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**The Challenge Now:
To Run the Gauntlet**

In our Summer 1981 issue, General Poe wrote that the U.S. had indeed reached a critical juncture in history. He challenged us to run the gauntlet toward totally responsible leadership and management of our ever more fragile (delicate) resources.

In this issue, Secretary Carlucci and General Mullins continue the dialogue and spell out even more so the extent of that gauntlet.

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AIR FORCE JOURNAL of LOGISTICS

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AIR FORCE JOURNAL of LOGISTICS

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Research, Development and Logistics

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Commander
Air Force Logistics Command

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Air War College

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Chief, Materiel & Logistics Management Studies
Air War College

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Department of Contracting Management
School of Systems and Logistics
Air Force Institute of Technology

Mr. R. A. Reaka
Chief, Logistics Career Program Branch
Office of Civilian Personnel Operations

Graphics

Mr. Bob Ryan
Ms Peggy Greenlee

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CONTENTS

Purpose The Air Force Journal of Logistics is a non-directive quarterly periodical published in accordance with AFR 5-1 to provide an open forum for presentation of research, ideas, issues, and information of concern to professional Air Force logisticians and other interested personnel. Views expressed in the articles are those of the author and do not necessarily represent the established policy of the Department of Defense, the Department of the Air Force, the Air Force Logistics Management Center, or the organization where the author works.

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We Must Do It

The Honorable Frank C. Carlucci
Deputy Secretary of Defense
Washington, D.C. 20301

What more do we need to do as members of the Department of Defense team? One of the things we all can do to support our President is to manage our own house better. While we have made many changes in DOD as part of an effort to do this, the cornerstone lies in our program to make the acquisition process more efficient.

Before discussing this process it might be useful to review the threat issue so that we can better understand what will be expected of us in the 80s.

The threat as you are well aware is real, large and growing. It has both a political and a military dimension. The former has been made evident in events from Angola and Ethiopia to Afghanistan and Poland. The latter is of direct concern to us who have special responsibilities for deterrence through strength.

You are all too familiar with the Soviet's large military buildup—4 to 5 percent per year in real terms—coming just at a time when we were disinvesting, in real terms, in the equipment needed to keep our armed forces strong. The result has been a loss of our strategic edge and a serious imbalance in conventional forces. For example:

- They have 3 times as many tanks, and produce them at a rate of 3 1/2 to 4 to 1.
- They hold a balance in tactical aircraft of 2 1/2 to 3 to 1.
- They produce ICBMs at a rate of 3 to 1 and SLBMs at a rate of 2 1/2 to 3 to 1.

One can cite many more such statistics. The point is that the trends are in their direction and they have substantial momentum. To be sure, they will face problems in the 80s—labor shortages, declining growth rate, topping out of oil production and leadership succession—but none of those is likely to deter them from budgeting up to 14 percent of their GNP into a continued military buildup. It certainly has not in the past. Areas, I see, of likely emphasis will be:

- *ICBMs*—to include increased accuracy, reliability, greater survivability of new generation systems.
- *Theater Nuclear Forces*— to expand the modernization and improvements in short- and medium-range systems based in Europe. Unless countered by the West, the deterrent value of NATO's nuclear forces will reduce.
- *New naval weapons*— to reduce the vulnerability of Soviet ships and submarines and improve their capabilities to contest Western use of open ocean areas.
- *Airlift and sealift*— to increase the potential which could give the Soviets a capability for long-range projection of military power in the 1990s. If the trend toward increasing involvement in the Third World continues, the Soviets will use the capability more actively.

These weapons are not being built for defensive purposes. They are being built to give the Soviets a greater ability to carry out and support their political aims.

The reality then, is that we and our allies may have to cope with bolder Soviet military initiatives, carried out both indirectly and through proxies in many parts of the world. We face the possibility of conflicts in many widely separated areas; in Central Europe, in the Persian Gulf, in Africa, in East Asia, or in the Western Hemisphere. In fact we may have to deal with more than one conflict at a time, or we may have to contend with a conflict in one area without opening up critical vulnerabilities elsewhere.

Handling such contingencies simultaneously could stretch our military resources thin. The growth of the Soviet ability to project power to many key points beyond their periphery dramatically increases their options while complicating our problem. It is imperative that we have a global strategic approach capable of dealing with Soviet oppression on a worldwide basis.

Such a goal cannot be accomplished by assigning a fixed quantity to the number of wars we mean to be able to fight simultaneously. Our commitments may perhaps be quantified, but the contingencies connected with them cannot be assigned numeric values. That is why I feel the old notion that we are prepared for 1 1/2 or 2 1/2 wars has no present validity.

Obviously we mean to honor our commitments to our own people and to our allies around the world. In doing this, we cannot shape our forces and doctrine, as we have in the past, solely on the assumption that there would be an initial conventional defense to aggression, followed by a quick nuclear escalation and then succeeded with a clean and early end to the war. Our loss of nuclear superiority calls such a doctrine into question. Consequently, this administration has instituted the strategic changes necessary to give us the option of fighting a very long war, when and if necessary. Our defense of freedom demands no less.

Our ability then to meet the growing threat depends crucially on a much stronger industrial base. We must rebuild our basic defense industries which have been too long neglected.

DOD ACQUISITION PROCESS

One of our early acts was to review the entire Defense Acquisition Process. This review culminated in 32 initiatives in the way we do business. Let me highlight some aspects of this program.

EXCESSIVE COSTS

At the top of any list of problems in the DOD, and of the defense industry, is excessive cost—both from the standpoint of what we get for the dollars we spend and what we spend that the critics think is unnecessary. Some cost increases are unavoidable, and we must face up to factors such as inflation, advances in the state-of-the-art, and unavoidable changes in production schedules. However, we will continue to work hard to cut back on those costs which can be controlled.

One key area in which we believe costs may be significantly reduced is government participation in contractors' internal management. Accordingly, the DOD is making real and substantive efforts to reduce government red tape. At the same time, however, we intend to monitor overall contractor progress against contract goals more closely.

We are convinced that the free enterprise system operates better and more efficiently with a minimum of micro-management from us. For example, we are working to

review the instructions and directives which have accumulated over the years so that we can eliminate those we do not need. We will continue to search for ways in which the cost of doing business with this Department can be reduced. In return, we expect industry to cut down on their overhead costs as well.

Industry has been on record demanding relief from big government. We are now going to do our part.

CAPITAL INVESTMENT

When we talk reduced costs, we also recognize that more capital must be made available to increase productivity. Therefore, we will continue to encourage more capital investment by firms doing business with the DOD. This was emphasized in our initiative paper of April 30, 1981.

Long-term investments will lead to lower unit costs and higher productivity, and we have taken a number of actions to assist industry in this effort. For example, we are working on such initiatives as flexible progress payments, advanced funding, economic price adjustment clauses, and modifications to the profit formula. It is vitally important that our contractors move on their own to match our efforts.

In addition there are many areas where industry should now be able to plan for early investments in tooling, plant, and equipment which will pay off in higher quality and more efficient production rates.

We must approach this problem on a team basis, because in providing joint solutions we share in joint results.

MULTI-YEAR PROCUREMENT

We are strongly supporting multi-year procurement as a further incentive to justify increased investment, to reduce costs, and to help stabilize programs. I have no doubt that we can ultimately save 10 to 20 percent of unit equipment cost by the proper use of this technique. Industry can better utilize existing facilities, invest in facility modernization, switch to large scale purchase of parts and material, and decrease costs of borrowing capital.

We recognize that multi-year procurement will not yield the benefits intended unless this concept is properly applied. The Defense Department should not solicit quotes which do not fully conform to the new criteria established for the use of multi-year procurement. When we are in error industry should not respond to our solicitation and should notify the proper procurement authorities. This entire process will and should have intense scrutiny by Congress. Thus, if we are to succeed, our utilization of the multi-year procurement procedure must be carefully planned and applied, and industry must devote the highest levels of attention to contract performance and management.

LEADTIMES

Every study of the acquisition process concludes that leadtimes are too long and are getting longer. One of our approaches to this problem is to cut down on the layers of bureaucratic review, and to delegate authority and decision-making downward whenever possible. Industry must join this effort by reducing the time it takes to respond to our requests for bid and the time needed to make in-house decisions. The old saying "time is money" has never been more appropriate, and this applies to both public and private sectors.

EARLY FUNDING AND "BUY-INS"

A persuasive case has been advanceu that the early phases of development of a new weapon system must be adequately funded. I support this in principle; however, industry has a major responsibility to identify accurately and fully the costs of its proposals. Industry must not commit itself to artificially low costs during the competitive bidding process and subsequently then blame DOD for inadequately funding the program. Nor should industry attempt to "buy-in" to the program.

We have included an attack on this long-time problem in our 30 April decisions, but industry can cut off the "buy-in" at its source by not submitting quotes which are unrealistically low in the expectation of "getting well" later during further performance on the contract.

We will be firm in rejecting recognized "buy-in" in the future.

THE PRODUCT

It is easy, when talking about acquiring military systems, to overlook the most important item in the entire process, the product. We must remember that the product flows from an initial research and development effort, to its manufacture, and eventually ends up "in the hands of the troops" so to speak, where its quality and reliability are the final test.

To assure that industry is provided maximum opportunity for innovation, we in Defense must eliminate complicated specifications and let industry know in the simplest possible terms what we need.

We want equipment which requires the least number of operators and which is easiest to support. We must avoid hardware so sophisticated that it cannot be properly maintained by our users. Whenever possible we would like to see more reliance on commercial off-the-shelf components and equipment. In short, industry must contribute by designing the best, least complicted operating and support features into the equipment delivered to the DOD.

INDEPENDENT RESEARCH AND DEVELOPMENT

The DOD has historically relied heavily on independent R&D performed by private industry. The result of this reliance is shown in a history of solutions to some of our toughest problems, and today those developed products now greatly enhance the capabilities of weapon systems. We may often lose sight of the importance of this program and its long-term results in our rush to solve near-term problems. For this reason I want to stress the need for industry to allocate a meaningful portion of independent R&D to emerging technologies which may offer the potential of breakthroughs for weapons systems of the future.

MANUFACTURING TECHNOLOGY

The need for upgradıng the manufacturing capabilities and facilities of the Defense industry has been addressed earlier. The costs of producing the product are directly related to the quality of the manufacturing process. Industry has the prime responsibility for identifying and for implementing improvements to manufacturing technology, including full use of processes as computer aided design and computer aided manufacturing, including robotics.

Of paramount importance, however, is the quality and reliability of the product delivered. These are vital elements of an effective weapon system. Much has been written in recent months regarding the alleged inability of American industry to match the standards of its international competitors, especially the Japanese. This is all the more ironic, since the Japanese attribute much of their success to the use of American concepts and methodology for quality improvement. I cannot imagine a more provocative challenge to U.S. industry than to demonstrate the ability to build the highest quality products, using the most efficient manufacturing technology.

I, therefore, suggest that the industry leadership of this

country establish a national commitment to improve the quality and reliability of its products, along with a dedication to improve our national across-the-board productivity.

THE INDUSTRIAL BASE

One of the most serious problems we face today is that of our declining industrial base. As the House Committee on Armed Services reported at the first of this year: "The defense industrial base has deteriorated and is in danger of further deterioration."

We have taken a number of steps to alleviate this condition. Tax incentives dealing with depreciation of plant and equipment have been written into law. Our contractors are being rewarded for innovative manufacturing techniques through incentives in their contracts. Our initiatives include special efforts to keep industry in the Defense business and to encourage new suppliers to enter the competition.

COMPETITION

In my testimony before the Senate Armed Services Committee, I stated that competition is basic to the whole acquisition program. As a follow-up to that statement, I have requested the Services to increase their efforts to obtain more competition by setting specific objectives. Thus we now have underway a rigorous effort which will involve goals and scorekeeping. I am also convinced that the measures industry is taking to obtain greater competition can be subjected to even tougher ground rules. We will soon lose the confidence of the American people if they believe we have failed to adequately use competition in the procurement process.

GOVERNMENT/INDUSTRY RELATIONS

I have repeatedly referred to our actions in the Department of Defense from industry's viewpoint. And that is because we have no chance of improving the acquisition system without working the problem side-by-side. That is why we have placed improved relationships between the Defense Department and its contractors high on our list.

As President Reagan recently said:

> "Today the United States stands virtually alone among the industrial nations in the adversary nature of the relationship between its government and the business industrial sector. . . ."
>
> ". . . Both business and government will have to learn to lay aside old hostilities and assume a new spirit of cooperation and shared responsibility. . . ."

In this spirit of cooperation we must work as a team throughout the acquisition process, from the development of requirements to the delivery and support of hardware at the operating level.

We can, and must, share this responsibility as partners, not adversaries.

LEGISLATION

A final item is the need for legislative action. We are in the process of presenting to Congress a number of legislative initiatives. This is a somewhat new approach for the Department of Defense, which in the past has often been reticent to step up and openly initiate and support legislation in this area. But we badly need legislative relief from a multiplicity of laws which impede our ability to follow sound business practices.

CONCLUSION

In conclusion, I want to stress again that during the last nine months there has been a substantial change in philosophy and policy with respect to acquisition of the products and services used by our Armed Forces. The Department and industry—have a long way to go—a tremendous task—to assure that these changes are implemented all the way down the line.

Change is never easy nor comfortable in any organization, but American business understands this perhaps better than any other segment of our society; for the ability to change as requirements change has been one of its great strengths.

Now change is needed.

We are seriously concerned about the Defense industry—especially with respect to the fundamental strength of the Defense industrial base— its costs, its productivity, the quality and reliability of its products, leadtimes, and diminishing capabilities in major manufacturing areas—and industry's ability to respond to normal demands as well as to meet surge and prolonged emergency requirements.

More importantly, industry is the residual strength which represents the ultimate deterrent. In America there is no captive defense industrial base—the Armed Forces must rely upon contractors.

I realize that many of you veterans of the procurement wars will say you have heard all this before. That may certainly be true, but the problems we have discussed are too critical, and involve too many billions of dollars, for us not to make an all-out effort to resolve them.

Be assured that we will not be sidetracked.

We are going to need all the support we can get—from Congress, from industry, and from you in the services. We have a paramount public trust—the security of this nation, which means a defense second to none.

Most Significant Article Award

The Editorial Advisory Board has selected "Some OSD Perspectives on Logistics Planning and Defense Readiness: The Last Decade and a Preview" by Charles W. Groover, as the most significant article in the Fall 1981 issue.

Scarcity and the Challenge

General James P. Mullins
Commander
Air Force Logistics Command
Wright-Patterson AFB, Ohio 45433

The Free World is in trouble, and American democracy is in trouble. The Soviet threat to our democratic way of life is both real and pervasive. Over the past two decades they have increased their military forces, while we have decreased ours. They now have four times as many tanks, and twice as many aircraft. The Soviets also have about one and a half times as many sea-launched and intercontinental ballistic missiles, and three times as many attack submarines. And they have well over four million men and women in uniform—twice as many as we have.

Forty years ago, at a time when the threat to the free world was also real and pervasive, Franklin Roosevelt delivered his famous "Arsenal of Democracy" address to the American people. In that speech Roosevelt said, "We must be the great arsenal of democracy. We must apply ourselves to our task with the same resolution, the same urgency, the same spirit of patriotism and sacrifice as we would show were we at war." Again, we find ourselves now faced with a serious threat to our way of life. And we find ourselves now, as we did then, the arsenal of democracy for the free world.

Unfortunately we are not now, I believe, ready to come to our own defense. This great arsenal of democracy which served the world so well in the past 80 years has withered in the face of a decade of neglect. To be precise, our arsenal's problems fall into four vital areas. *First,* we have a scarcity of many critical raw materials. *Second,* we lack the skilled workers to produce the weapons we need. *Third,* we have seen hundreds of defense suppliers, with all their experience and all their expertise, simply vanish over the past few years. And finally, *fourth,* many of our defense plants today have become obsolete—they are suffering from old age and neglect.

Let us look at these issues more closely. There is today a serious shortage of strategic metals and raw materials. Consider, if you will, the Pratt and Whitney F-100 engine for our F-15 and F-16 warplanes. Because of a shortage of titanium processing capacities, delivery times have recently doubled. It now takes 41 months for delivery; it used to take only 19 months. Waiting times for the bulkheads and wing spars for the F-15 have increased as much as 65 weeks since 1975. And with the increased delivery times have come increased costs. For example, the price of cobalt used in the F-15 and F-16 engines skyrocketed 246 percent after the 1978 Shaba rebellion in Zaire. Consider the raw materials we must have to defend our freedoms. Think about titanium, manganese, tantalum, cobalt, platinum and chromium. Modern technology makes us dependent on these materials for our future survival; yet, geographical and political realities make their certain availability rather uncertain indeed.

Almost as scarce as these specialized materials are the specialized, skilled workers who must use them. We have gotten ourselves into a manpower squeeze in which engineers, computer experts and trained, blue collar workers are in very short supply, and when they are available they are subject to fierce, competitive recruiting. We recruit only 25 percent of the machinists each year that we must have just to keep pace with normal attrition. We now look at potential shortfalls of 33 percent for engineers, 49 percent for computer specialists and 84 percent for statisticians.

But strategic materials and trained people are only half our shortage. The number of subcontractors who provide vital components and assemblies to prime contractors has also diminished and must be recognized as a problem. The number of aerospace suppliers alone is down almost 42 percent. Uncertainties in budgets and contracts have forced more and more of them away from military work. In 1967 we had about 6,000 aerospace contractors; today we have closer to 3,000. This shortage in subcontractors has in turn reduced competition, inflated costs, and so increased delivery times as to bring into serious question our ability to meet any long-term Soviet threat. And as I said earlier, I fear the threat is here—today!

The fourth, and the last part of the shortage equation is the problem we face in meeting a Communist challenge with our aging defense plants. Equipment is worn out and operations are inefficient. In fact the output of many plants is severely limited. We are ceasing to be competitive. Almost 80 percent of our government-owned machine tools and almost 60 percent of our aircraft metal-working equipment is over two decades old. For years now we have been living off the industrial fat of the '50s and '60s. Now the fat is almost gone.

In World War II our military industrial might produced over 310,000 aircraft in just 44 months. Today it takes over two years alone to get only a few landing gear parts. I want you to think about the production of Franklin Roosevelt's arsenal of democracy. Think about the 900,000 military trucks, the 411,000 artillery pieces, and the 88,000 tanks. Think about the 358 destroyers, the 211 submarines, the 27 aircraft carriers and the 10 battleships, and think about all of this production in just 44 months. Could our military industries do this now? Can we rely on present production to keep us free? Can we wager the security of our future generations on the game we now are playing?

Our readiness to defend our way of life must depend, to a very great extent, on private industry's ability to supply the means of national defense. And it is in industry's best interest to supply these means. The relationship between the productivity of private enterprise and the defensive might of America is synergistic. Each needs the other to survive. American government must keep our way of life democratic, must provide a free environment to sustain industry's functioning and growth. Industry, on the other hand, has a responsibility to government; it must provide the tools for the nation's defense.

Historically, the private sector has always played an important role in the planning and provisioning of weapons for American defense. During the Revolutionary War, when we needed ship construction and artillery parts, the private sector supplied them. Since then, in times of crisis, our defense has always enjoyed the full support of private industry, namely, its research, its industrial ingenuity, and its expanded productivity. We are now again in a time of crisis. And we must now again depend on our great industrial capabilities.

Now this brings me specifically to international logistics and the contribution it must make to solving our problems. Although there are great parallels today with the fears and

threats prevalent in the era of Franklin Roosevelt and the pre-world-war days of 1940, we must also realize that there are many significant differences. One of the most significant, I believe, is the growing interdependence of the non-Communist nations, on one hand, and the increasing need for cooperation between the public and private sectors within those nations, on the other hand.

We in the U.S. have a great responsibility to aid our friends and allies. Because, by helping them, we are really helping ourselves. One of the most effective ways to provide this aid, it seems to me, is to increase the effectiveness of their military forces, thereby fostering their regional stability while enhancing our defense production capabilities. And in the process, we can hopefully achieve our most sacred goal—the prevention of war itself.

Franklin Roosevelt noted in his Arsenal of Democracy speech that the width of the oceans bounding our country is not "what it was in the days of clipper ships." Rapid diffusion of communication and transportation technology in our world over the past couple of decades has intensely proven the validity of his statement. As Roosevelt concluded, "We will know that we cannot escape danger, or the fear of danger, by crawling into bed and pulling the covers over our heads." I believe we must cast aside these covers. We must do everything we can to insure the survival of our friends, and in so doing, the survival of ourselves.

I see this survival, then, as the most important function of our international logistics programs. We must insure that our allies are well prepared for the struggle ahead. This is absolutely essential to our well-being. The world is an amalgam of political relationships, an infinitely complex group of discrete national entities where definite limitations exist on what any single nation can do alone. We must join with our allies to provide for our common defense. And at the same time, we must insure these friends are strong enough to defend themselves—that they are strong enough to maintain political and economic stability in their own regions.

Recently we have seen our international logistics programs continue to increase, with over sixty countries currently participating in Air Force foreign military sales. Obviously our major efforts must continue to be with those nations whose resources and strategic locations make them absolutely vital to our well-being. We must continue to develop these programs because we must continue to help ourselves.

Providing this security assistance in the future isn't going to be easy. But no one ever said it was. We are now faced with increasing lead times for production, non-availability of weapons systems, and politically sensitive issues. I know full well that our resources are finite, that if we take hardware to fill one need, we must often create a shortage somewhere else. But let me emphasize that we have no choice but to succeed. We have no choice but to somehow reconcile these requirements. We must be the advocate of our allies, for we are, in the final analysis, their arsenal of democracy as well as our own.

Item of Interest

USAF LOGISTICS CAPABILITY ASSESSMENT SYMPOSIUM

The second Logistics Capability Assessment Symposium, LOGCAS 82, will be held at the United States Air Force Academy, Colorado, on 15-19 March 1982. The symposium will be convened by Major General T. D. Broadwater, Director, Logistics Plans and Programs, Deputy Chief of Staff for Logistics and Engineering, HQ USAF. Brigadier General William P. Bowden, Deputy to Maj Gen Broadwater, will be the Symposium chairman and Colonel Joseph M. Campbell from the Logistics Concepts Division, AF/LEXY, will be the vice-chairman.

The purpose of the symposium is to provide a forum for professional Air Force analysts and project managers involved in logistics capability assessment to present programs to their peers for critique and sharing of ideas.

The theme of the symposium is "Logistics Capability Assessment Modeling - The New Management Techniques for the 80s." The conference will focus on determining Logistics Capability Assessment models, techniques, topics, and projects presently in use, under development, and in the planning stage.

Members of Logistics Capability Assessment Community and other interested parties are urged to contact the Executive Secretary for additional information.

LOGCAS 82 Executive Secretary
AFLMC/LGY (Major Cochard)
Gunter AFS AL 36114

USAF
LOGISTICS CAPABILITY ASSESSMENT
SYMPOSIUM
82

USAF LOGISTICS POLICY INSIGHT

Harvest Bare Enhanced

In September 1981 the Harvest Bare Technical Improvement/ Enhancement Conference was convened at HQ USAF/LERX in order to identify solutions and initiate corrective actions on known deficiencies existing in the equipment and facilities. There has been increased emphasis on the enhancement of bare base equipment due to the lack of a logistic infrastructure in Southwest Asia. Operation from bare bases in this harsh and hostile environment requires resources to perform aircraft maintenance and provide housekeeping support. Special resources are needed to offset the environmental extremes in this region, e.g., dust, sand, windstorms and temperatures that range from 20° to 130°F. The next program review, scheduled for January 1982, will address the status on those identified action items.

Changes in Financing Policies

DoD contract financing policies have changed as directed by the Deputy Under Secretary of Defense (Acquisition Management) on 28 August 1981. Included in the new policies is a new contractor financing method, *flexible progress payments*. This method allows the contracting officer to determine the appropriate contract progress payment rate (between 90% and 100%) for individual contracts to suit the circumstances of the acquisition. See Air Force Acquisition Circular 81-3 for policy details.

Readiness Structure Explained

Maintaining and improving the combat readiness of our forces has always been a basic Air Force goal. The Logistics Readiness and Supportability Panel (LRSP), chaired by the Director, Logistics Plans and Programs (AF/LEX), acts as a logistics readiness coordinating body for the DCS, Logistics and Engineering (AF/LE). Panel membership includes representation from throughout the Air Staff. The Logistics Initiatives Control Center (LICC), within the Combat Logistics Division (AF/LERX), supports the LRSP by providing centralized tracking of logistics readiness initiatives being worked by the Air Staff. The LICC is responsible for developing readiness initiatives from across the Air Force into a coherent, integrated program with clearly defined milestones, costs, and manpower impacts. This readiness structure enhances the initiatives staffing process and insures upward visibility and support for logistics readiness programs. It insures that readiness efforts are visible, coordinated, and support an essential objective—Readiness NOW.

New R&M Regulation Prepared

HQ USAF is preparing a reissue of the Air Force regulation on reliability and maintainability. The present number, AFR 80-5, is being replaced by AFR 800-18; the change reflects the increasing emphasis on R&M during the acquisition cycle. The new regulation includes implementation of DOD Directive 5000.40, Reliability and Maintainability, and will be published in early 1982.

Toxic Storage Rules Changed

A recent change to AFR 87-3 implements portions of DODI 6050.8, 24 Aug 81, and prohibits the outgranting of Air Force facilities for the storage or disposal of Non-DOD-owned hazardous or toxic materials. These materials are defined in Public Law 96-510, Comprehensive Environmental Responses, Compensation and Liability Act of 1980, and Federal Standard 313A and include materials of an explosive, flammable, or pryotechnic nature. Exceptions to this policy, other than those described in the change, must be processed to HQ USAF Real Property Division (LEER). Your Base Real Property Officer can provide you with details of the recent change.

EOD Role Clarified

Explosive Ordnance Disposal (EOD) capability is often considered an exclusive logistics activity due to the organizational structure of the units. However, when total air base survivability and recovery after an enemy attack are examined, we find that EOD must play an expanding role in all base recovery actions. The interdependence of EOD and the Civil Engineers Rapid Runway Repair (RRR) has long been recognized. Now EOD forces must be employed to support other base recovery activities as well. The use by an enemy of technologically sophisticated ordnance will have a significant impact on the capability of EOD to meet all base recovery actions in a timely manner. This requires that command and control of base recovery actions be integrated to insure that EOD manpower, time, and equipment are utilized in the most effective manner. HQ USAF/XOORB has been established as the Air Staff focal point for the integration of all policy affecting air base survivability. Explosive ordnance disposal policies are now viewed in concert with the other air base survivability activities outside the logistics arena.

Vehicle Prepositioning Expanded.

Our credibility to defend vital Western interests against a wide range of threats will continue to depend on our ability to augment or establish our forces rapidly in overseas locations. Although our reinforcement capabilities are somewhat limited at present, many serious problem areas are being scrutinized. Of primary importance are efforts to improve strategic mobility and to provide adequate prepositioning of needed assets. The deployment of our forces will require direct mission support vehicular equipment to transport crews, handle munitions, tow, refuel, and maintain aircraft, distribute cargo, and provide basic personnel transportation at operating locations. Acquisition and prepositioning of this equipment at theater locations will significantly reduce strategic and tactical airlift requirements and will provide our forces with an immediate reaction capability. Vehicles to be procured for prepositioning have been identified by using commands and appropriate planning, programming and budgeting actions are taking place.

Interservice Support

The Defense Retail Interservice Program (DRIS) program enables commanders to acquire support services from other Military Services/Defense Agencies through the media of Interservice Support Agreements. It also helps to reduce DOD costs by serving as a vehicle for eliminating duplicate support capabilities between local activities. The Secretary of the Air Force has requested full management attention to achieving the DRIS objectives recently set by the Deputy Secretary of Defense: meeting annual $10 million savings targets in FY 1983 - 1987 and completing the DRIS Studies Plan by FY 1983. All Air Force activities are encouraged to participate.

Provisioning Policy Changes

A revision to DODD 4140.40 which governs DOD provisioning policy will soon be published. This revision places emphasis on readiness as a criterion for spares range and quantity determinations and establishes the principle that provisioning must begin early in the acquisition process. The revised directive, for the first time, authorizes the use of techniques that the Air Force pioneered called Spares Acquisition Integrated with Production (SAIP). Air Force Regulation 65-2 which implements DOD provisioning policy is currently in coordination. Its publication will follow issuance of the new DOD policy by several months.

Emergency Contracting Policy Improves

Seventeen action items to improve emergency contracting support planning resulted from a Contingency Contracting Conference held at Tinker AFB, Oklahoma in October 1980. Action on most of the items will be completed by the end of 1981. Emergency contracting policy changes encourage more coordination among functional areas and between MAJCOMs in contingency planning, require more involvement of contracting in planning for deployments, and increase the authority and flexibility of deployed contracting officers to be more responsive to mission support requirements.

New 9mm Handgun to Join Inventory

On 14 May 81, the Under Secretary of Defense for Research and Engineering approved the acquisition plan for the 9mm personal defense weapon. This handgun will replace all standard handguns used within DOD and the Coast Guard with a single family of handguns using NATO standard ammunition. When authorized by Congress, this plan will provide the Air Force 84,000

handguns over a five year delivery period beginning in FY 83. The conversion of weapons will require close monitoring and planning of ammunition requirements to enable inventory transition from .38 caliber to 9mm.

MAC Air Passenger Terminal System Modified

Over a two year period MAC will shift more contract military passenger flight operations from military terminals to commercial gateways. MAC currently operates passenger contract flights from Philadelphia, Los Angeles and St Louis. Concurrent with the move of international military passenger operations from military to civil terminals, MAC will implement a readiness terminal concept at military passenger terminals which are collocated with parent military airlift wings. These military terminals will be immediately available in wartime and, in peacetime, minimally manned for the residual workload associated with military airlift operations. Readiness terminal locations include McGuire AFB, NJ; Dover AFB, DE; McChord AFB, WA; Travis AFB, CA; and Norton AFB, CA.

Personal Property Shipping Offices to be Consolidated

The Deputy Secretary of Defense directed the development of a plan for consolidation of Personal Property Shipping Office (PPSO). As a result, an ad hoc working group, including service representatives, was established to identify potential candidates for consolidation. The consolidation plan submitted to OASD(MRA&L) calls for the elimination of 23 PPSOs (seven Army, nine Navy, four Air Force and three Marine Corps) with all but one being replaced with a "one-stop" processing office. Eighteen of the existing PPSOs (four Army, five Navy, and nine Air Force) will be established under a new organizational structure called Central Booking Offices. First-year savings are estimated at $3.0 million. Consolidation will reduce requirements for maintenance of Data Automation Systems and for administrative personnel. Manpower savings will be directed to personal property quality control functions to enhance customer service. An identical review will soon begin for all overseas Traffic Management Offices.

Multi-year Procurement Guidelines Set.

The Deputy Secretary of Defense, on 1 May 81 issued a policy memorandum which established guidelines for the expanded use of multiyear procurement (MYP). The use of MYP for major systems and equipment acquisitions and its increased use for supplies and services is intended to reduce the costs of goods and services as well as stimulating contractors to improve productivity. The memorandum contains a policy statement, definitions of terms, guidelines for applying MYP and approved methods for structuring MYPs.

Contractor Operated Stores Upgraded

The Air Force has taken steps to improve its contractor-operated parts stores for both vehicle parts and civil engineering supplies. Specific improvements include a new COPARS contract format that puts greater responsibility on the contractor to estimate requirements and more responsibility on the government to establish prices. Tighter surveillance and internal controls will also be implemented to help blunt recent GAO criticism of the contractor operated stores concept.

Local Purchase Efficiency Improved

The Air Force contracting community has made a major commitment to upgrade the efficiency of the local purchase program and customer responsiveness at base level through improved application of modern ADP technology. The program to accomplish this is nicknamed COPPER ICOMPS, short for Contracting Improved Computer Support. The program consists of two phases. Under Phase I, efforts are underway to improve the existing base level automated purchasing system (CIAPS) through changes which will streamline and simplify its operation. Phase II efforts are concentrated on identifying, designing, and implementing a system employing state-of-the-art ADP technology to replace CIAPS. All organizational levels of base contracting, from users to staff policy makers, are contributing to both phases of COPPER ICOMPS.

PCS Carrier Claims Judged Useful in Selection Process.

Claims payments are normally made at PCS or "new" installations while carrier selection which directly impacts the care and movement of personal property is made at the "old" duty station. Procedures are being studied to determine the feasibility of an automated information loop that would permit traffic managers to apply claims information when selecting the lowest overall cost carrier. Data

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APPLICATION OF SCHEDULING HEURISTICS TO THE USAF AIRCRAFT MAINTENANCE DEPOT*

Lieutenant Colonel Thomas D. Clark, Jr. USAF
Associate Professor of Systems Management
School of Engineering, Air Force Institute of Technology,
Wright Patterson AFB Ohio 45433

Second Lieutenant Joseph W. Adams, Jr. USAF
Airman Programs Analysis Officer
Directorate of Personnel Programs
Hq United States Air Force, Washington DC 20330

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Abstract

The application of scheduling heuristics to manage the flow of aircraft in a maintenance depot is discussed in this paper. A Q-GERT model of the depot maintenance process at the Warner Robins Air Logistics Center was developed and used to test several scheduling algorithms. Results indicate a reduction in the mean depot flow time can be obtained by adjusting priorities at several work stations and applying varying priority selection rules.

Introduction

An analysis of scheduling for depot level maintenance of USAF aircraft at Warner Robins Air Logistics Center (WRALC) is presented in this paper. The objective of the analysis is to provide the production manager at the depot with scheduling rules that will assist in achieving more efficient use of the depot facilities and resources. The analysis involved development of a Q-GERT network model which can provide the schedulers, who program aircraft through the depot for the using Air Force commands, with more realistic estimates of the depot's production capacity and the time required by individual aircraft for depot-level repair.

Depot utility is a measure of the benefit the Air Force derives from the operation of the depot facilities. As the time an aircraft spends in depot repair is decreased, the time the aircraft is available for operational use is increased. If the quality of work done at the depot remains constant with the decrease in depot time with a given level of resource input (manpower, material, etc.), the depot utility will have increased. Since scheduling rules affect only the order in which aircraft are serviced and not the service itself, the quality of work was assumed to be independent of any scheduling rules that may be applied at the depot. This assumes that jobs have independent set up times which is the course followed in this research. In practice, some jobs may have set up times which can be jointly shared with other jobs that are started simultaneously. If this effect is present in the system it should be included or the results of any study could be slightly biased.

Three different types of aircraft use the depot facilities at Warner Robins. The extent to which depot resources are used by any particular type of aircraft can be assumed to be [is] a function of the mean and variance of the probability distribution of the time spent at the depot for each type aircraft. This relationship is demonstrated in the equations:

$$\text{Resource Required} = R(\mu_i, \delta_i^2)$$

$$\text{Depot Utility} = U(\mu_1, \delta_1^2, \mu_2, \delta_2^2, \mu_3, \delta_3^2)$$

Where μ_1 is the expected value of the time an aircraft remains in work. The utility function is simply a means of determining the preference of one set of means and variances versus another. Since many of the facilities that are common to all types of aircraft at the depot have associated with them a waiting time, total time spent at a particular facility by an aircraft can be assumed to [will] depend upon the demand for the facility by all other aircraft. Thus, the means and variances of the probability distribution for each type of aircraft are interdependent. For example, specific scheduling changes made to reduce the mean for aircraft of Type A may result in a corresponding increase in the means for aircraft types B and C. The utility function is necessary to determine whether such a change is beneficial. For different loading of aircraft into the depot and for each type of scheduling rule employed to determine the order in which waiting aircraft will use busy facilities, there will be a unique set of means and variances and correspondingly a unique level of utilization. Thus for these different depot loadings of aircraft, the production manager must know which scheduling rules to employ to maximize utility.

When the depot process is modeled as a network of queues with stochastic service times, the continuous long term nature of the process can be evaluated. As the model simulates several months of the depot's operation, statistics are gathered measuring average waiting and flow times for each separate facility in the system. The exact nature of these statistics will be explained after the model is presented and discussed. These statistics provide the scheduler with more realistic estimates of the total flow times upon which to base due dates and plan for further arrivals. More importantly, these statistics measure the effects of any scheduling rules applied to the system and are the means of illustrating the potential for increasing total utility for a variety of aircraft loadings at the depot. Such scheduling rules, hereafter called heuristics, can also be based on due date information from the schedulers or even the history of an individual aircraft. Statistics gathered over a range of heuristics can provide insight and understanding into the relationships among individual facility flow times, waiting times and loading of aircraft at the depot.

System Structure

The depot at WRALC is responsible for programmed depot maintenance (PDM), modification, and analytical condition inspections (ACI) for both the C-130 and C-141 cargo aircraft as well as technical modifications made on the F-15 fighter aircraft. In addition, aircraft of the above three types requiring miscellaneous depot level repairs use the facilities. Both PDM and ACI are an intensive series of structural and functional tests and repairs performed upon the air frame [body] and systems of each aircraft. The [steps] associated with PDM and ACI are identical except the structural inspection is expanded during an ACI. The entire depot process is represented in the structural diagram of Figure 1. The PDM or ACI portion of the Figure 1 process is shown in Figure 2.

Apart from the actual PDM portion of the process, the depot facilities can be assumed to be [are] common to all aircraft types. This provides the production manager with the opportunity to assign a higher priority to an aircraft type when the depot is overloaded with one type due to delays in the PDM portion of the process or to a sudden increase in the input rate of that aircraft type. Of course, for such a scheduling heuristic

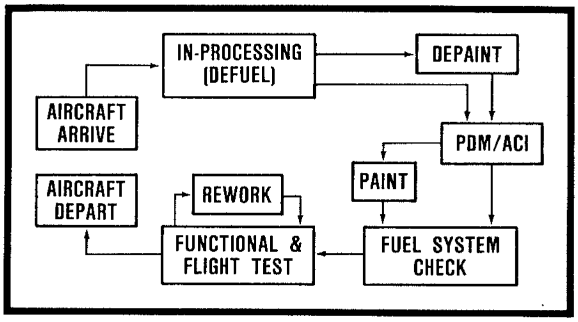

Figure 1.
Structural Model of the Depot Process

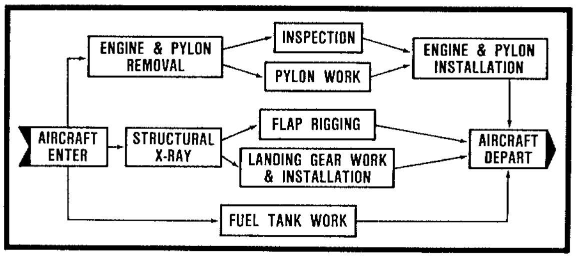

Figure 2.
PDM/ACI Portion of the Depot Process

to be successful, the set of means and variances obtained after its implementation should yield a higher utility than the preheuristic set. Then, the success of the heuristic implies that the reduced priority of other aircraft types at the common facilities does not increase their mean and variance enough to result in a lower utility.

Assuming that the depot experiences are overloads in only one aircraft at a time, the heuristic just discussed will have the effect of reducing change in the mean time at the depot due to an overload. Thus the variance for each type over a period of a number of such overloads will be less than variance obtained without the heuristic. Then the schedulers can plan arrivals over an extended period with greater confidence when such a heuristic is employed. The model developed in this research provides a vehicle for testing various scheduling heuristics given the current state of the system. Thus, the effects of priority adjustments can be evaluated.

Priority Scheduling Rules

A heuristic is any systematic set of rules which constitutes a method for solving problems (2). In the case of a job shop structure such as the depot, a heuristic is the proper scheduling rule for a given system state to maintain a desired level of utility. The state of the system is defined by the set of jobs awaiting service in each queue in the system. Since the number of system states [is] infinite, it is impractical to have and to apply a unique heuristic for every system state. Instead system states must be grouped in some manner so that one heuristic applies to an entire group of system states. For example, group A may represent all system states such that the number of jobs in the arrival queue is between the minimum number in the system at any time and the maximum number at any time for that group. Thus, the approach defined by the systematic application of heuristics based on a grouping of system states does not provide an optimal solution all the time. However, depending on the breakdown of the system states, the heuristic approach does provide a consistent solution which maintains a desired level of utility with a minimum amount of computational effort (12).

The number of possible combinations of heuristics is virtually endless. The best guide to choosing types of heuristics to test on a particular system is a good working knowledge of system structure along with a familiarity with the heuristics most commonly used in such structures (15). Following is a list of the common types presented in the literature for structures typical of the depot.

1. *First-Come-First Serve (FCFS) - Priority only depends on time job entered queue.*
2. *Shortest Operating Time (SOT) - Requires an estimate of the service time for each job in the queue. If the queue length is always greater than zero, the longest job may never be serviced. Conceptually, the longest job will eventually be processed whenever the system's utilization is less than 100%. The flow time for the job will be quite large.*
3. *Static Slack (SS) - SS is equal to due date minus time of arrival. Thus external scheduling information is needed to assign priorities. Job with least expected time in the system is given highest priority in each queue.*
4. *First in System, First Serve (FISFS) - Highest priority is given to job which entered system first.*
5. *Last in System First Serve (LISFS) - Most recent entries into the system are given highest priority.*
6. *Dynamic Slack (DS) - DS is equal to time remaining till due date minus remaining expected flow time. Job nearest due date and requiring most work is given highest priority (12).*

The usefulness of any of these rules or combinations thereof depends on the level of utility achieved by its application. In addition, if a heuristic is found to be useful, the user must in fact determine the range of its usefulness.

The SOT rule was of primary concern in early research of complex network systems since studies with single server systems had shown that the rule produced the best results in terms of minimizing flow time (21). In 1963 Nanot tested ten heuristics, including the six listed, using six different job-shop structures. The SOT rule performed the best, leading to a minimum flow time (17). The rule, however, did exhibit a relatively high variance which did cause undesirable flow times for about 1% of the orders. Conway and Maxwell tried to eliminate this disadvantage by imposing limits on waiting times and by alternating the SOT rule with the low variance FCFS rule (3). Generally, they found that there must be some trade-off between variance and mean flow time.

Further studies have recognized that multiple criteria exist for evaluating results. These include percent of late order, average waiting time, labor utilization, and machine utilization. The concept of multiple criteria closely corresponds with the concept of a utility function. LeGrande developed a job shop simulation model using six priority dispatching rules, judged on the basis of ten criteria (13). Again the SOT rule had the best overall ranking. Berry has experimented with heuristics which take into account due date information (1). He found the static rules (priority does not change once assigned) of this type, where due dates did not change during the job's time in the system, out performed the dynamic rules (priorities may change after initial assignment) where all external information was constantly updated (1,2).

Research, therefore, indicates that the simple SOT rule exhibits the greatest potential for decreasing flow time but at the risk of higher variances. In addition, heuristics that employ external information, perform best when this information is not updated. Therefore, those heuristics requiring a minimum of state and external information usually outperform the more complicated types. The SOT rule along with the simple heuristics discussed earlier for assigning priority to an aircraft type was tested using the model.

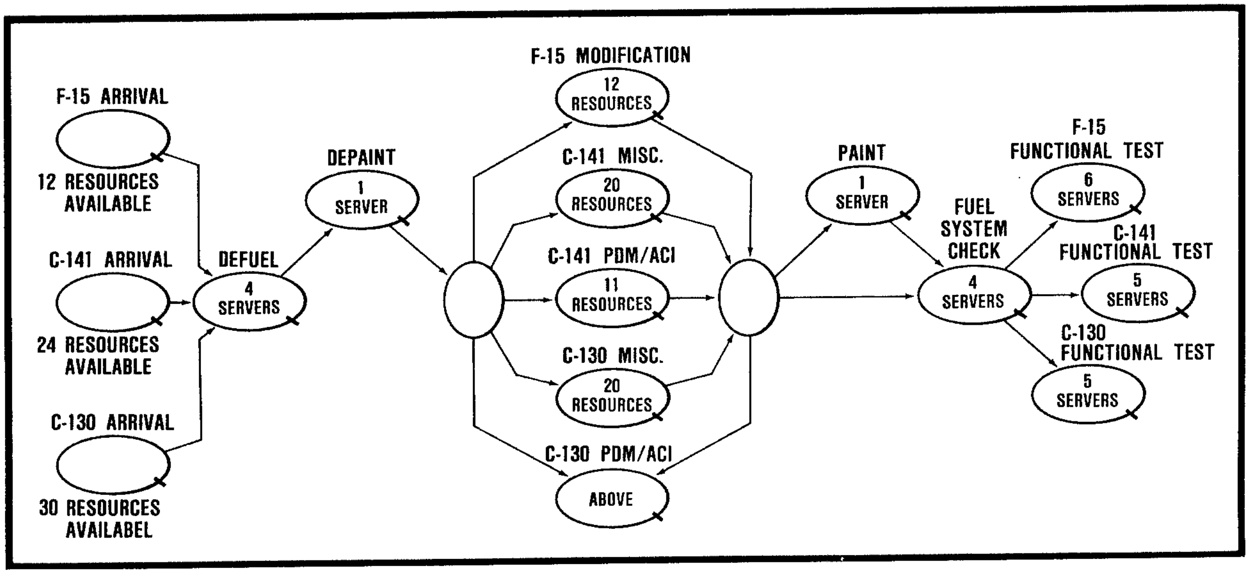

Figure 3. Model Flow Diagram

Model Structure and Testing

The job shop structure was modeled with the Q-GERT simulation language. It provided several advantages for testing the priority rules and for representing the structure at Warner Robins. A simplified flow diagram of the model is shown in Figure 3.

The depot capacity is critically limited by the number of each type of aircraft that can be hangared at any given time. The hangar limitation is imposed irrespective of the type of services required by an aircraft. In Figure 3 these limits are shown as resource constraints at the arrival queues. An aircraft which arrives when no resources are available must wait until an aircraft of the same type departs and frees the hangar resource. There are also limits to the number of aircraft undergoing PDM/ACI and miscellaneous repair at any one time. The limiting factor in this case is manpower. In Figure 3 these manpower resource limits are shown at the PDM/ACI and miscellaneous repair queue for the C-130 and C-141 and at the F-15 technical modification queues.

Much of the branching in the model is determined by aircraft type. Since the model remembers the type of each aircraft in the system, this branching is said to be deterministic. Branching which controls flow to PDM/ACI or miscellaneous repair, and paint and depaint, is accomplished probabilistically. Probabilities for each branch are calculated using actual flow data from the depot. Service times at each node are stochastic. There may be a separate distribution for each aircraft time at one queue.

Priority dispatching rules or heuristics are applied at the various queues in the model in order to specify the order in which waiting aircraft will use busy facilities. Note that no wait is necessary for an aircraft in the arrival queue or the PDM/ACI and miscellaneous queues unless the corresponding resource is not available.

The activities performed during the PDM/ACI portion of the depot process are shown in Figure 2. The process was modeled with information gained from depot managers. The structure of this portion of the process differed from that of the depot model because certain activities in the PDM/ACI process can occur simultaneously. Two separate models are used, therefore, in the research; the "depot model" at the overall process level and the "PDM/ACI model" at the intermediate process level.

Referring to Figure 2, the steps constitute nodes which represent the start or end of one or more activities. Activities which start from the same node begin at the same time and thus occur simultaneously. However, before any such activities can begin at a node, all activities which end at this node must be completed. Thus the activity time between nodes will correspond to the longest of the simultaneous activities. This type of system is amenable to a Program Evaluation Review Technique (PERT) Management. The Q-GERT language is well suited for modeling this type of pattern so this part of the model appears as a PERT process. The "PDM/ACI model" outputs the mean and variance for the PDM/ACI total activity time distribution. The purpose of the "PDM/ACI model" was as an aid in estimating total time in this portion of the process for a specific aircraft so that the shortest operating time (SOT) heuristic could be employed. Times can be estimated for each activity in the PDM/ACI process based on the aircraft's former PDM time and the present condition of the aircraft. Inputting these times into the "PDM/ACI model" results in an estimate of the total time required for PDM/ACI for a specific aircraft. The information generated is then used in the "depot model".

Six months of historical data were used to estimate the probability distribution for the service times and the branching probabilities. Service time distributions were found to approximate the normal distribution except in the case of a constant service time. The distributions were tested with a Chi-square goodness of fit test at an alpha-level of 0.05. The data base corresponds to a period where C-141 aircraft were being overloaded into the depot. Testing the model under different loading conditions may invalidate the model; therefore, for tests of other periods additional data would be required.

Shortages of parts needed during the PDM/ACI process were not explicitly considered in the model. However, minor delays caused by such shortages were incorporated into the service time distributions. The type of rework required was not specified. Instead rework times were averaged for each aircraft and included in the functional test portion of the process.

Although the F-15 is painted and depainted at the same facilities as the C-130 and C-141, the facilities were modeled separately. There is sufficient space at the facilities for one C-141 and one F-15 or one C-130 and one F-15. Thus, service for the F-15 is independent of the service of the other two aircraft types.

Whenever two or more aircraft are waiting for the same server to become available, some type of rule must be applied

TABLE I

PRIORITY SELECTION RULES

Heuristic		No. of Days Priority Paint (P)	No. of Days Priority Depaint (D)	No. of Days Priority at Fuel Leak Check (F)	Use of SOT Rule at PDM/ACI (S)
Base	(1)	0	0	0	No
S	(2)	0	0	0	Yes
P,D+10	(3)	10	10	0	No
P,D+10,S	(4)	10	10	0	Yes
P,D,F+10,S	(5)	10	10	10	Yes
P,D+20	(6)	20	20	0	No
P,D+20,S	(7)	20	20	0	Yes
P,D,F+20,S	(8)	20	20	20	Yes
P,D+30	(9)	30	30	0	No
P,D+30,S	(10)	30	30	0	Yes
P,D,F+30,S	(11)	30	30	30	Yes
P,D+40	(12)	40	40	0	No
P,D+40,S	(13)	40	40	0	Yes
P,D,F+40,S	(14)	40	40	40	Yes
P,D+50	(15)	50	50	0	No
P,D+50,S	(16)	50	50	0	Yes
P,D,F+50,S	(17)	50	50	50	Yes
P,D+60	(18)	60	60	0	No
P,D+60,S	(19)	60	60	0	Yes
P,D,F+60,S	(20)	60	60	60	Yes

TABLE II

RESULTS OF MODEL TESTS

Heuristic	C-141 Mean	C-141 Variance	C-130 Mean	C-130 Variance	F-15 Mean	F-15 Variance
Base	55.49	39.19	30.49	6.75	43.22	9.61
S	55.19	36.72	30.14	7.73	41.66	5.57
P,D+10	55.10	29.59	30.63	8.29	42.16	6.15
P,D+10,S	54.56	27.25	30.60	6.30	41.69	5.02
P,D,F+10,S	55.07	22.18	30.87	3.96	42.62	7.18
P,D+20	54.23	22.37	30.76	7.45	42.32	6.71
P,D+20,S	54.67	35.76	30.77	5.57	42.34	4.67
P,D,F+20,S	54.31	14.44	31.57	10.69	41.46	5.62
P,D+30	55.26	30.8	31.23	16.89	42.65	10.82
P,D+30,S	55.5	21.07	31.82	11.22	42.47	8.70
P,D,F+30,S	53.56	20.16	31.06	9.00	41.97	6.15
P,D+40	54.29	15.52	30.51	8.94	42.06	5.34
P,D,+40,S	56.3	26.21	30.90	12.67	42.19	8.07
P,D,F+40,S	54.45	14.29	31.28	12.46	42.40	7.51
P,D+50	56.18	27.67	32.07	17.89	41.71	7.02
P,D+50,S	56.27	33.29	32.35	14.24	42.15	7.24
P,D,F,+50,S	55.19	22.56	30.92	10.11	41.72	5.52
P,D+60	55.46	20.16	32.06	11.22	42.97	10.50
P,D+60,S	55.01	25.40	31.73	9.30	42.77	7.51
P,D,F+60,S	53.89	7.51	31.01	9.55	42.10	6.3

to determine the order of service. The heuristics to be tested are these scheduling rules which are applied to the queues in the model. The rule now used at the depot is the first in system first served (FISFS) rule. Thus aircraft are always serviced in the order they enter the depot. Results using the FISFS rule at all queues, therefore, were used as a basis of comparison for all other heuristics.

Based on the literature review and the applicability of priority heuristics discussed previously, two types of priority selection rules were selected for demonstration testing. The first heuristic which is to be used at queues representing common facilities is a slight variation of the FISFS rule. Priority was assigned to an aircraft type, in this case the C-141 because the depot was saturated with them, by adding a constant to the average number of days of flow time for aircraft of that type were in the system. This constant caused the selection rule to recognize the aircraft first if it entered at the same time as another type. The FISFS rule was then used. Thus, if a C-141 and a C-130 had actually entered the depot on the same day, the C-141 would always be served first since the model concludes that the C-141 had arrived first. The level of priority, which is the number of days added to the depot time of the C-141, can be increased simply by using a larger constant.

The SOT rule is used at the C-141 PDM/ACI queue in an effort to increase the flow of C-141 aircraft through this stage of the process. Since the average length of the queue is only about one, the problem of a large variance usually associated with the SOT rule is avoided.

The priority heuristics at varying levels were applied to the paint and depaint queues and/or the fuel leak check queue with and without the SOT heuristic in effect at the PDM/ACI queue. This assignment strategy is shown in Table I. These results represent different strategies for each simulation of the system. The paint, depaint, and fuel leak check queues possessed the longest waiting times in the base case, and thus it was assumed the priority heuristic (adding days to average flow times for C-141 aircraft) would have the largest impact when applied to these queues.

The results of each combination of selection rules applied to the model are shown in Table II. Each set of results represents average statistics from thirty runs of the model, where each run represents one year's operation of the depot. The analysis of these results will consist of finding the heuristic or heuristics which have provided the greatest improvement in the C-141 statistics while showing any undesirable effects in the statistics of the other two aircraft. In these experiments, priority is given to both the C-141 and F-15 aircraft at the fuel leak check queue. This change was made to prevent significant increases in the F-15 statistics which occurred during earlier runs when only the C-141 aircraft was given priority.

The largest decrease in the mean of the C-141 time distribution corresponds with the heuristics which assigns a 30 day priority at the paint, depaint, and fuel leak check queues and applies the SOT rule at the C-141 C-141 PDM/ACI queue. The larger the decrease in the mean, the larger will be the increase in C-141 depot capacity. The indicated decrease of 1.93 days in the C-141 mean corresponds to an increase, all other factors equal, in depot capacity. The significance of the 1.93 day decrease is discussed in the next section.

The largest decrease in the variance of the C-141 time distribution corresponds with the heuristics which assign absolute priority at the paint, depaint, and fuel leak check queues and apply the SOT rule at the C-141 PDM/ACI queue. Schedulers can plan future arrivals with greater confidence when the variance is decreased. In this case, the variance has decreased 81% from the base case. In the base case, a scheduler could be 95% confident (assuming normality in the distribution) that a C-141 aircraft would spend between 42.97 and 58.01 days at the depot. After applying the heuristic the range of the C-141 depot days becomes 48.41 and 59.37. Thus the interval drops from 25.04 to 10.96 days.

The only undesirable effect of either of these two "best" heuristics is a 1.6% increase in the mean and 41% increase in the variance of the C-130 time distribution. Since the C-130 aircraft is the only type which spends no time waiting in the arrival queue, this increased variance should cause minimal problems for the schedulers. The F-15 aircraft statistics have actually improved for both heuristics. Since the F-15 aircraft was also given priority over C-130 aircraft at the fuel leak queue, this result is not surprising.

Conclusions

If the undesirable effects upon other aircraft types are minimal as indicated, then the production manager can apply the recommended scheduling heuristics and be highly confident of improving the situation at the depot. The model provides a vehicle for testing various options given the current state of the system and driving heuristics that improve depot flow time, thus increasing capacity.

The results in Table II clearly indicate that performance does not always increase with level of priority. The C-141 aircraft statistics gradually improve as priority is increased until they peak at between thirty and forty days priority. Performance then declines with higher priority assignments but is much improved with absolute priority. At greater than sixty days priority, the results from the model become independent of the level of priority. The probability that a C-141 aircraft would be in the same queue with another aircraft type which had arrived sixty or more days earlier, is essentially zero for this depot model. Thus the C-141 would have infinite priority at all queues which employ the priority heuristic. A C-130 aircraft would only be serviced if no C-141 aircraft were in the same queue.

The results in Table II do indicate that application of the priority heuristic at all three common queues in addition to the SOT rule at the PDM/ACI queue is the best strategy for a given level of priority. These three common queues were chosen because they exhibited the longest waiting times. Thus the production manager, if he uses the above strategy, need only find the optimal level of priority.

Using the same procedure used in this paper, the production manager can find the optimal level of priority. Of course, the model used would have to be sufficiently tested to ensure validity for various data structures. The model could be part of a routine which would input the present loading of aircraft at the depot and output the optimum priority assignment. Undesirable effects would be constrained by setting limits on the mean and variance of other aircraft types and excluding those priority assignments which exceed these limits. In this way the production manager could realize the potential of the priority scheduling heuristics.

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"If one were to be asked what an internal combustion engine disliked most, high on the list would come sand, salt, heat, and humidity."

Air Chief Marshall Sir David Lee, RAF
in *Flight From the Middle East.*

CAREER AND PERSONNEL INFORMATION

Enlisted Skill Shortages: A Two-Tiered Promotion Modification

Background

The Air Force is currently suffering severe shortages of career personnel. We commonly refer to this as a "middle management" shortage, or more specifically a middle grade NCO shortage. The obvious impact is in the shortage of experienced people to support the Air Force mission and concurrently train new people entering active duty. The problem is exacerbated by a concentration of shortages in certain direct mission support career fields, occasionally referred to as "sortie producing skills." When these skills remain short of career people over a period of time, they are referred to as "chronic critical shortage skills" (CCS).

Why are some skills chronically short? The answer is extremely complex and involves a number of variable factors. Some of these factors are *systemic;* i.e tough and demanding jobs, skills that are in high demand in the private sector, and skills that require substantial training lead time. Other factors are *structural* in nature. For example, some career ladders lack the manpower authorization structure that will produce the number of people required to fill middle grade requirements. They are, therefore, not self-sustaining. Yet another factor is the changing size of the Air Force. When the SE Asia hostilities ceased, the Air Force had to reduce the force (declining end strength). Now we are in a force building mode (annual increases in end strength). When force size builds, the need for middle and upper grades increases, and this requires retention of people to enter and remain in the career force. Until the past year, our retention of people entering the career force failed to meet the needs for skilled and experienced production and supervisory people. Hence, retention is the key factor.

As you can see, there is no single or easy "fix" to this complex problem. Instead, a wide range of actions are required to address each of the causative factors. Targeting on the CCS skills, possible initiatives such as a comprehensive AFSC restructuring program (to fix the problem AFSCs where authorizations are not self-sustaining), substantially increased selective reenlistment bonuses, prior service recruiting efforts, retraining programs, and adjustment of high year of tenure restrictions are specific examples of efforts to solve skill imbalances. The promotion modification, with a two-tiered approach to selection rates, is just one of several initiatives to reduce or eliminate experience shortages in the CCS skills.

What Is It?

Simply stated, the promotion modification is a *temporary* three year program with a fairly simple purpose. It is intended to *encourage* people to *remain* in the CCS skills and also to *retrain* into these skills. Within this framework, it will, hopefully, provide an environment for rebuilding experience in the CCS skills by reducing loss rates from separation and retraining, and through infusion of career oriented people into these consistently imbalanced career fields. The CCS promotion selection rates will be 5 percentage points higher than the non-CCS career fields for promotion to staff sergeant, technical sergeant, and master sergeant. This is because the majority of Air Force shortages are concentrated in these grades and skills (five and seven skill level), and are further concentrated in certain skills with severe shortages. Presently, there are no extreme shortages in lower or higher grades that warrant targeted promotions.

Equally important is *what it is not.* The promotion modification is not an instant cure for experience shortages. Promoting more people does not immediately create more experience. Rather, it is a *promotion environment* that will help build experience in the CCS skills. Secondly, it is not a program that lessens promotion opportunity in other skills. This is important because of the dangerous misconceptions that could occur. Third, it is not an effort to define skills that are more or less important to the Air Force team concept. Instead, it is a recognition that we cannot achieve mission objectives with strength on one part of the team and weaknesses in other parts. Lastly, and perhaps most important, this modification is not a return to the former promotion management list (PML) concept of promotion by career field. The modification remains an equal selection opportunity system, but with two-tiers.

Chronic Critical Shortage Skills

We have already defined grade and skill level shortages, now we will define the criteria used to determine the CCS skills. First, the candidate

career fields must be mission readiness essential. This means that the specialty must meet the criteria of those AFSCs listed in AFR 55-15, "Combat Readiness Reporting." The second requirement is a substantial deficit in skill level manning. This is defined as a specialty with 80 percent or less seven level manning, or with seven level manning less than 90 percent and combined five and seven level manning less than 90 percent. The third criteria is that the shortages must be persistent, hence chronic, with no anticipated get well date. To qualify as a CCS skill, all three of these criteria must be met.

When a skill is identified as a CCS, it remains on the CCS list for three years barring unforeseen authorization reductions that would drive up the manning. All skills will be reviewed annually. The initial review resulted in a listing of 65 CCS skills. Forty-seven of these are logistics skills in aircraft, munitions, missile, and ground communications/ electronics maintenance. To put this in perspective, we are projecting 11,300 shortages in staff sergeant thru master sergeants in the CCS skills through the end of September 1982.

This represents an 18 percent shortage, or said another way, nearly one of every five E-5 thru E-7 authorization will not be filled with the required grade/skill. Focusing on the overall aircraft maintenance skills, 9,300 shortages will exist representing 82 percent of the total CCS shortages. This highlights the need to field an entire team to meet mission objectives and the concomitant need to solve these imbalances.

Source of Added Promotions

If, as previously stated, the two-tiered promotion selection rate will not lessen promotions in non-CCS skills, there must be additional total promotion authority to support the 5 percent higher rate for CCS skills. It is generally known that promotions in the top six grades are limited by total manpower authorizations. For example, if we are authorized 4500 chiefs, we cannot promote above that level through the end of the fiscal year. To support the two-tiered program, additional promotion authority was required. The Secretary of Defense has authorized additional promotions for FY82 which will have a small but important effect on enriching the middle grade structure. We expect about 4600 additional promotions this year and the modification will put approximately 1600 more of them in the CCS skills. That is less than 4 percent of the total staff sergeant through master sergeant promotions, but focusing them into the 65 CCS skills will permit a 5 percent higher selection rate. All skills will realize more total promotions, but the CCS skills will benefit by a slightly higher margin.

Implementation

The two-tiered promotion modification will be in effect beginning with the January 1982 SSgt list. A listing of CCS skills has been provided to all base personnel offices and senior enlisted advisors under the cover of a HQ AFMPC CBPO Letter 81-101. We have included some additional information and a list of frequently asked questions and answers. To provide additional information, each major command has dispatched a briefing team to inform all bases and units on this program. While this effort is nearly complete, additional overall promotion publicity will be provided throughout 1982.

Summary

It is extremely important to understand the purpose of the two-tiered promotion modification. Those who expect it to be an instant and complete solution to retention and experience shortages will be disappointed because it is only one of several related initiatives. Therefore, overall success in retaining people in the career force and within skills with severe shortages cannot be credited or blamed on any one initiative. Hopefully, the temporary promotion modification will help provide the basis for building and maintaining a balanced team of career professionals.

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Civilian Career Management: LCCEP

PROMOTION EVALUATION PATTERNS (PEPs). A PEP is a standard that measures experience, supervisory appraisal, awards, and managerial potential appraisal (MPA). Individuals are ranked in order of qualifications set forth in the PEP for a particular position or cluster of positions. PEP development is a very lengthy process and must be validated according to standards which are set forth in the Office of Personnel Management X-118 Qualifications Standard. The automated PEPs utilized in the Logistics Civilian Career Enhancement Program (LCCEP) have been under development and testing for three years and are the first ones used on a centralized career program by a PALACE Team in the Office of Civilian Personnel Operations (OCPO), Randolph AFB TX.

However, PEPs for career programs are not developed by the OCPO PALACE Team. They are developed by a functional work group composed of specialists in the logistics family that the PEP is intended to support (i.e., supply, transportation, maintenance, logistics management). One of the primary tasks of the functional work group then is to review all position descriptions covering LCCEP program positions and cluster together like positions to hold the number of PEPs required to a minimum. As a result of this action, there are 194 PEPs used to respond to fill requests for approximately 1,144 positions in LCCEP. Furthermore, to measure the experience of individuals, the Personnel Data System-Civilian (PDS-C) is utilized to look at the records of all registrants to identify individuals with the best experience. For this reason, the functional work group must accomplish a thorough job analysis of the position and determine the weight to be assigned to each bit of knowledge, skill, or ability needed to perform each major job requirement. That is where the expertise of the work group membership really pays off in the validation process. Membership of a work group represents MAJCOMs having a representative number of positions to be filled under the LCCEP. After job analysis/validation, the work group then determines the skills that will be placed in the progression level factors (PLF) of the PEP which is determined by the weight of the various qualifying skills assigned by the work group. The first PLF is very broad and includes all skills which are basic at the next lower grade level. Another PLF is used to identify individuals with the basic 36 months specialized experience required by the X-118 Qualification Standards. Each subsequent PLF narrows down the number of individuals to those with the best experience to perform in the particular position to be filled. After those individuals with the best experience are identified, they are ranked in order of the average percentile of supervisory appraisal and MPA on the basis of previously decided award points. The work group then reviews the results on an Air Force-wide basis to determine if the PEP produced the best candidates for the vacant position. When the work group is satisfied that this objective has been accomplished, the PEP is submitted to the Air Force PEP Panel for final approval. This panel is chaired by Mr. D. K. Jones, HQ AFLC/LO, who is responsible to the LCCEP Policy Council for PEP development. Other members of this panel are: Roy Haberlandt, SA-ALC/MA; John Kenney, OO-ALC/MMS; Clive Courtney, OC-ALC/DPCC; Sammie Whitehead, HQ AFSC/LGX, and Jim Clifford, SM-ALC/DPCS. W. P. Arnold is the OCPO representative to provide panel support.

Once the Air Force PEP Panel approves the PEP, the OCPO LCCEP Program Branch can use the PEP to fill requests for program actions. The process does not end here. There is a continuous review of all PEPs for updating purposes. Skill codes may change in the PDS-C or new ones may be added, all of which require continuous surveillance.

A microfiche copy of each LCCEP PEP has been provided every servicing civilian personnel office for use in providing information to registrants regarding qualifications. The microfiche is scheduled for updating semiannually. To conclude, PEP is proving to be another valuable management tool.

The following is a summation of LCCEP activity for the last fiscal year.

LCCEP ACTIVITY

1 Oct - 30 Sep 81

	Cadre Reserved	Career Essential
CERTIFICATES ISSUED:	98	90
Selections:		
Cadre	57	15
Non-Cadre	15	38
Outstanding Certificates	14	21
Promotions	64	50
Lateral Reassignments	8	3

VACANCIES BY GRADE:

GS-12	GS-13	GS-14	GS-15	Total
35	40	37	13	125

EEO DATA:

Referrals:	1,107	Selections:	125
Male:	1,024 (93%)	Male:	110 (88%)
Female:	83 (7%)	Female:	15 (12%)
Minorities:	145 (13%)	Minorities:	15 (12%)
	(includes male and female)		(includes male and female)

Source: OCPO/MPKCL, Randolph AFB TX (AUTOVON: 487-4087)

"In a period of inflation the increased costs of provisioning may well be logged by the budgetary system far more precisely then the inflation in the ambient national economy."

Group Captain R. A. Mason, CBE, RAF,
in *Readings in Air Power*.

Modification of the Standard Base Supply System Stock Leveling Techniques

Major Kenneth B. Faulhaber
Chief, Stockage Policies Division
Air Force Logistics Management Center
Gunter AFS, Alabama 36114

Abstract

This article identifies recommended changes to the Air Force Standard Base Supply System necessitated by DOD Directive 4140.44, Supply Management of the Intermediate and Consumer Levels of Inventory and the supporting Instruction 4140.45, Standard Stockage Policy for Consumable Items at the Intermediate and Consumer Levels of Inventory. Current range of stock leveling methodology is identified for replacement by range of stock computations that consider economics of operation as well as demand history. Also, changes to the current depth of stock computations are suggested. The impact of these changes to current leveling computations on performance was evaluated through the use of the simulation technique.

Introduction

The lack of sufficient spares to support aircraft and other weapon systems has long been recognized as a significant weakness of our military. What probably has not been so widely recognized is that many of these spares are not the highly complex and sophisticated components that are required to operate our modern weapon systems. Rather, many of these scarce spares are low cost, consumable assets such as rivets, resistors, diodes, nuts, bolts, screws, gaskets, seals, etc. Within the Air Force these low cost, consumable items account for approximately 80 percent of all assets stocked at base level supply accounts, representing only about 15 percent of inventory investment for supply spares. Of critical importance is the fact that these relatively low dollar value items today account for as much as 50 percent of all Air Force aircraft grounding incidents. Therefore, any improvements in stockage positions or supply support for these assets become very attractive when comparing mission support improvements against any required additional inventory investment. A basic problem in the development of such improvements has always been the proper assessment of two basic issues - when to stock an item at the retail level and, once stocked, what depth of stock is required. Since funding constraints and the possibility of generating unacceptable excesses prohibit the stocking of all consumables at every base level supply account, an effective and selective stockage decision process is essential.

The Air Force Logistics Management Center (AFLMC) has addressed this problem, having recently completed the development of new retail level stock leveling techniques for consumable items that provide improved support for those assets currently grounding aircraft, vehicles, and aircraft engines. This improved support is projected to range from an 11 percent reduction in grounding incidents to a 40 percent reduction, depending upon the particular end item and base or weapon system. These modifications to current stock leveling techniques are scheduled for implementation by Dec 81 and are presented below.

The Air Force's current retail level supply system, known as the Standard Base Supply System (SBSS), was developed in the early 1960s. The acquisition of the UNIVAC 1050-II computer system was a key element in the development of the SBSS and, together, these two factors propelled our retail supply functions into a truly data automated mode of operation. As its name implies, the SBSS is indeed a standard system that provides support to the entire range of Air Force weapons systems and functional operations at the base level. Since its inception the SBSS has been both highly successful and extremely dynamic. Modifications, both major and minor, have been continuous. Changes have resulted from the necessary reaction to changing operational scenarios; those modifications, encouraged throughout the functional element, to improve support for existing operations, those developed as a result of improved technological capability, and those directed by the Department of the Air Force or the Office of Secretary of Defense. The Air Force's Data System Design Center is charged with systems modification, if not the actual design, while HQ Air Force establishes the Center's priorities.

The Air Force Logistics Management Center, established in the mid-1970s, is charged with developing improvements across the entire logistics spectrum. The stockage policy modifications presented below were developed at the AFLMC from November 1978 through December 1980. The AFLMC report entitled "Modifications to the Standard Base Supply System Stock Leveling Techniques," Report Number 161138, should be referred to for more specific and detailed information than is found in this article. The requirements of Department of Defense Directive 4140.44 and Instruction 4140.45, published in 1978, set the basic guidelines for the analysis that led to these modifications. The major requirement of the DOD issuances is that various costs of operation be considered within the range and depth of stock computations. The provisions of these issuances apply to the Office of the Secretary of Defense, the Military Departments, and the Defense Agencies worldwide. They establish Department of Defense policies for the management of supply inventories of secondary items held below the wholesale level. (Secondary items are defined as end items; consumable items other than principal end items. Besides principal end items; e.g., aircraft, missiles, and vehicles, the DOD Directive also *excludes* ammunitions, subsistence, individual uniform clothing, medical materiel, bulk petroleum, and prepositioned war reserve materiel.) To fully comprehend the magnitude of these changes, a description of the current method for determining what range of items will be stocked at the retail level is necessary.

Current Range of Stock Computations

In the past, the decision to add an item to the range of items stocked at base level has been based on just two factors. These are the priority of the customer's demand, expressed as a Stockage Priority Code (SPC), coupled with the number of demands an item experiences since the date of first demand. Stockage Priority Codes range from 1 (the highest priority) for those items, the lack of which will ground aircraft, engines, vehicles, etc., through 4 which represents routine requests for stock. The number of demands over time is expressed as a

Daily Demand Frequency Rate (DDFR) and is computed by dividing the difference between the current date and the date of first demand into the total demands. If less than 365 days of demand experience is available, 365 days is used. If an item's DDFR equals or exceeds a certain threshold value for the SPC assigned, then a level is established and the item is stocked. No consideration for any costs of operation or an item's unit price is made with this approach. Table #1 shows the DDFR threshold levels and the equivalent number of demands necessary to reach a stockage decision for each SPC.

SPC	DDFR	Number of Demands
1	.0082	3
2	.0109	4
3	.0136	5
4	.0164	6

Current Range of Stock Decision Logic

Table 1

Certainly other methods are used to establish levels, such as special levels, but these modifications address only demand driven leveling techniques. While this approach has proven expedient in the past, critical considerations have been left out of the decision process. The individual item price as well as common costs of operation should be considered along with the customer's perception of need. In recognition of this, and the DOD guidance mentioned previously, coupled with the always limited funding for spares, the AFLMC developed the cost driven range of stock computations described below.

AFLMC Enhancements

These new cost driven computations consider unit price, demand history, administrative and inventory control costs of operation, and pipeline times from depots to the base or retail operations. The unit price is, of course, the cost of one item or its unit of issue in dollars and cents. The numerous administrative and inventory control cost factors incurred at the retail level are shown in Table 2 along with their respective values and definitions. These cost factors, while developed for Air Force use, are based on the logic and approach spelled out in DOD Instruction 4140.45.

Cost Factor	Value	Definition
1. Cost To Order	\$ 4.54 (\$15.84 for Local Purchase Items)	Costs Incurred for processing routine stock replenishment orders.
2. Holding Cost Rate	26% (Of Inventory value)	Costs Incurred with holding Inventory due to losses, obsolescence, excess, etc.
3. Cost to Add	\$ 3.38	Costs Incurred to compute a stock level.
4. Cost to Maintain	\$11.20	Costs Incurred to maintain an Item with a stock level.
5. Backorder Cost	\$ 2.55	Costs Incurred to establish routine customer requirement with no special depot requisition.
6. End-Use Order Cost	\$ 6.47	Costs Incurred when priority requisitions are submitted back to a depot to fill high priority customer demands.

Administrative and Inventory Control Cost Factors

Table 2

These cost factors were developed under separate studies and analysis within the AFLMC in support of this effort. Each was developed by first identifying the specific elements or tasks that made up each factor. Once identified, a cost was developed for each element. These costs were then combined to derive the total cost involved, such as, processing routine stock replenishment requisitions (Cost to Order), the costs involved with processing priority requisitions (End-Use Order Cost), etc. It should be noted that many of the elements or tasks comprising the various cost factors was dependent upon human actions such as remote inputs and verification of requirements. Therefore these factors must be periodically reviewed and adjusted, as required, to account for the fluctuations in personnel costs.

The total demand history of an item is also considered by the new cost driven computations. The total number of units of an item that has been requested, known as Cumulative Recurring Demands, and the total number of demands or requests for an item, referred to as Total Demands, are considered for a year's time. Additionally, the priority of demands is considered through the application of a Shortage Cost Factor. This variable factor, set at different values depending upon the priority of the customer's demand, serves to prioritize items based on their past demand and the customer's perception of need.

As previously indicated, the pipeline time between the source of supply and the retail supply function is also considered. These times, referred to as Order and Ship Times (O&ST), are collected at the retail level by source of supply and, for the purposes of this modification, are expressed in years; that is, the average of the recorded times divided by 365 (days).

A desired level of support is also considered by the computations. Identified as Line Availability, this factor represents a desired level of stock availability of 90 percent and is set at .9.

While it is recognized that an item essentiality scheme, applicable at the retail level, has not been developed, the capability to incorporate such a scheme into the range computations was established. This Item Essentiality Factor is set at a constant of one for all items, pending the development and application of such a scheme.

Finally, two factors are taken from the depth of stock computations to complete the range factors. These are the Reorder Point and the Economic Order Quantity, as determined by the depth computations.

Using all of the above factors, the cost driven range of stock computations determines which stockage decision, that is, to stock the asset at the retail level or not, is the most cost effective. To reach this determination, the various factors are combined arithmetically to determine three possible costs of operation as follows:

a. The Cost to Not Stock = The costs incurred when an item is not stocked and a level will not be computed or carried against the item.

b. The Cost to Stock = The costs incurred when a level is computed for an asset and it is added to the stock list. The

determination of this cost requires the computation of the cost to retain an item in stock.

c. The Cost to Retain = The costs incurred when an item is supported by a stock level and will be retained on the stock list.

Once determined, these costs are compared to derive the most economic leveling decision. The computations, therefore, determine the breakeven cost of adding an item to stock. Listed below are the arithmetic computations for determining each cost of operation:

a. The Cost to Not Stock equals:

$$S\,(E\lambda L + U)$$

Where:

S = Total demands per year
E = Item Essentiality Code
λ = The Shortage Cost
L = Mean Leadtime (O&ST) in years
U = End-Use Order Cost

b. The Cost to Stock equals:

G + the Cost to Retain

Where:
G = Cost to Add

c. The Cost to Retain equals:

$$F + (R - DL + \frac{Q}{2})IC + \frac{D}{Q} \times A + S(1 - \alpha) \times (E\lambda L + B)$$

Where:

F = Cost to Maintain
R = Reorder Point
D = Cumulative Recurring Demands
Q = Economic Order Quantity
I = Holding Cost Rate
C = Unit Price
A = Cost to Order
α = Line Availability
B = Backorder Cost

By comparing the results of these equations, the most cost efficient stockage decision is derived which results in a purely economic approach to the range of stock determination at the retail level. This approach, however, disregards the customer's urgency of need or the impact that the lack of a particular asset has historically had on the mission support posture. The accommodation of these factors, as well as the verification of the functioning of the actual computations, was the primary objective of the analysis conducted in this effort.

The Analysis

Simulation was the primary technique used to develop, analyze, and verify the cost driven range of stock computations. The System to Analyze and Simulate Base Supply (SASBS) simulation model was used for this purpose. This model simulates the performance of the Standard Base Supply System for EOQ items only. It uses actual historical demand data and actual item records with simulation results reflected using many of the current SBSS performance indicators. These include but are not limited to:

a. Availability of assets
b. Number and dollar value of receipts and requisitions
c. On-hand, on-order, and due-out inventory dollar value
d. Number of grounding incidents for vehicles, aircraft, and engines

To conduct the analysis, over 10,000 items from two SBSS accounts were used. Over 65,000 transactions were used to drive the model for a simulated time frame of one year for each account. The same data set was used for all simulation runs. First, the model was exercised without any changes to the stock leveling techniques to establish an SBSS baseline for comparative analysis. Second, the model was modified with the addition of a totally new routine representing the cost driven approach to the range of stock determination. This routine, once developed, was added as an option to be exercised separately from that routine representing the current range decision logic. The routine was designed to pass a simple "Yes" or "No" back to the main body of the simulation model. The "Yes" indicated that the computed Cost to Stock was projected to be less than the Cost to Not Stock. The model would then generate a level and place an order for stock to support that level. If a "No" was passed, it indicated that the Cost to Stock was projected to be greater than the Cost to Not Stock. In these instances, no level was established, no requisition for stock was placed, and the model simply processed a single requisition for the immediate demand and proceeded to the next transaction in the queue.

The initial analysis involved verifying the simulation model modifications. The new cost driven computations were checked to insure they operated correctly and were arithmetically accurate. Once this was determined, the reaction of the model itself to the Yes or No decision was observed to verify that the proper stockage actions were taken as required.

The second major effort involved the determination of a value or values for the Shortage Cost Factor. As indicated previously, this is a variable factor designed as a "tuning knob" to alter, as required, the systems performance. Using the SBSS baseline inventory dollar values as a target, the simulation model was exercised with various values for the Shortage Cost. As each different value was simulated, the results, as depicted by the model, were compared to the initial SBSS baseline results. Since funds are a limiting factor, that Shortage Cost value that resulted most closely to the inventory investment of the SBSS baseline was selected. At this point in the analysis two points became evident. While it was apparent that the new cost driven approach had possibilities, some consideration for the customer's perceived urgency of need for an item had to be recognized. This had been accomplished previously with the Stockage Priority Coding System which had not been incorporated into the cost driven computations. Without such modifications the new approach would be purely economic, thus ignoring the primary purpose of mission support. Therefore, separate Shortage Cost values were selected for each Stockage Priority Code 1 through 4. Using the one Shortage Cost value already identified as a starting point, numerous simulation runs involving combinations of Shortage Cost values by SPC were completed. As with the initial value, the combination of Shortage Cost values that resulted in an inventory investment closest to that experienced with the baseline was identified.

One major problem still remained with the cost driven computations, even with the incorporation of separate and distinct Shortage Costs based on the SPC. While the current range of stock logic guaranteed a leveling decision on the third demand for an item that was grounding an aircraft, vehicle, or engine, the new approach did not guarantee such a decision and was still basically economic in approach. Even though a large Shortage Cost had been identified for use with SPC 1 items (aircraft/vehicle grounding) it was conceivable that a stockage decision might not be reached on high priced items. Since unit price is a consideration of the cost driven approach, such high prices might very easily dilute the impact of the high Shortage Cost value and unacceptably delay the stockage decision. To overcome this, a guaranteed leveling decision for SPC 1 items was developed. Numerous simulations were required to determine whether the leveling decision should be

guaranteed after the first, second, or third mission grounding incident/demand. A limit was set at three, since it was essential that the new approach be at least as supportive of the mission as the current system. Retaining the SBSS baseline inventory investment as the target, the removal of SPC 1 items from the purely economic or cost driven approach required the identification of new Shortage Cost values for the remaining SPC 2, 3, and 4 items. This, once again, required numerous simulated runs with new Shortage Cost value combination for SPC 2 through 4 items coupled with the three different guaranteed leveling thresholds for the SPC 1 items. Ultimately a final configuration for the new approach was selected. A leveling decision is guaranteed for SPC 1 items after the very first aircraft/vehicle grounding incident. The Shortage Cost values selected for SPC items 2, 3, and 4 are set at 25, 10, and 4, respectively. In summary, the use of three separate Shortage Cost values prioritizes the various demands upon the SBSS by SPC and places added emphasis on the higher priority demands. For example, with all other factors equal, such as unit price, demand history, etc., the cost driven computations will establish a level on and commit stock funds toward an SPC 2 coded item before a 3 or a 4 coded item. Since SPC 1 requests involve the grounding of aircraft, vehicles, engines, etc., a purely economic approach was determined to be impractical. Therefore, the economic analysis is bypassed for these requests and a level is established automatically after the first such demand.

At this point in the study, one final factor was identified for analysis. The impact of the Variable Stockage Objective (VSO) within the depth of stock computations was selected for study. The determination of the Economic Order Quantity (EOQ) within the depth of stock computations is based on the following Wilson Lot Size Formula:

$$EOQ = \frac{Y\sqrt{\text{Annual Demand Rate} \times \text{Unit Price}}}{\text{Unit Price}}$$

$$\text{Where } Y = \frac{2 \times \text{Cost to Order}}{\text{Holding Cost Rate}}$$

Within the SBSS this formula is modified by replacing the Annual Demand Rate with a Daily Demand Rate multiplied by the Variable Stockage Objective as follows:

$$EOQ = \frac{Y\sqrt{\text{Daily Demand Rate} \times \text{VSO} \times \text{Unit Price}}}{\text{Unit Price}}$$

Where VSO may equal any one of the following values: 365, 90, 60, 45, 30, 15 or 0.

The VSO value selected depends on the SPC and demand history of the item. When applied at other than the full 365 figure the VSO reduces the level calculated to meet stockage requirements. While originally designed to commit limited funds against the higher priority requirements, this approach does select, under certain conditions, less than the full 365 figure for even SPC 1 items. Therefore, the impact of the VSO was selected for analysis.

The SASBS simulation model was again selected for this analysis. A relatively minor programming change to the model resulted in the selection of the 365 figure in all cases. This, in essence, reflected the use of the Annual Demand Rate. As in the case of the cost driven range computations, a baseline was established and then the new approach simulated for comparative analysis. This modification was then combined with the cost driven range of stock computations to determine the overall impact on the Standard Base Supply System performance and inventory investment.

Conclusions and Recommendations

The results of the final simulations with both modifications incorporated into the model were very encouraging. Inventory investment increased by about 7% which was anticipated with the use of the full VSO value of 365 in all instances. It must be noted that this represents only a one time increase and is projected to require approximately $20 million in additional stock funds. All measures of performance that are reflected by the model showed improvements. Overall, the availability of assets improved by about one percent. Both requisitions and receipts decreased by approximately 20 percent. While requisitions were tracked by priority group there was no discernable trend between the two accounts simulated. For one account the greatest reduction was experienced with Priority Group One, while the other showed the greatest decrease in Priority Group Three or routine stock replenishment requisitions. Nevertheless all groups showed reductions ranging from a low of 14.8 percent to a high of 24.6 percent. The reductions in aircraft and vehicle grounding incidents were also very encouraging. These incidents were also tracked for aircraft engines. These reductions ranged from a low of 11.1 percent to a high of 41.7 percent. These improvements are, of course, anticipated to continue beyond just the first year after the modifications to the stock leveling techniques are made.

While these improvements are most attractive, a word of caution is required. The use of simulation techniques in any analysis must be done carefully and with a full understanding of the limitations these techniques involve. In this specific case, the simulation model does not allow for any funds constraints which, unfortunately, all too often become a factor with our SBSS operations. For this and other reasons, the simulation results must be interpreted cautiously. While the level of improvements projected by the simulations might not in fact be achieved, what is most important in reviewing these results is not only the magnitude of the changes experienced but the direction of the changes and the consistency of these changes across the entire data base. All performance indicators available for review showed some impovements. For this reason it was concluded that these major modifications to the SBSS stock leveling techniques should be made and that the funds required to support them should be committed.

These major modifications to the Standard Base Supply System stock leveling techniques were formally presented by the AFLMC to HQ Air Force in December of 1980. Shortly thereafter the Air Force Data Systems Design Center began to develop the necessary software modifications for an Air Force-wide implementation by December of 1981.

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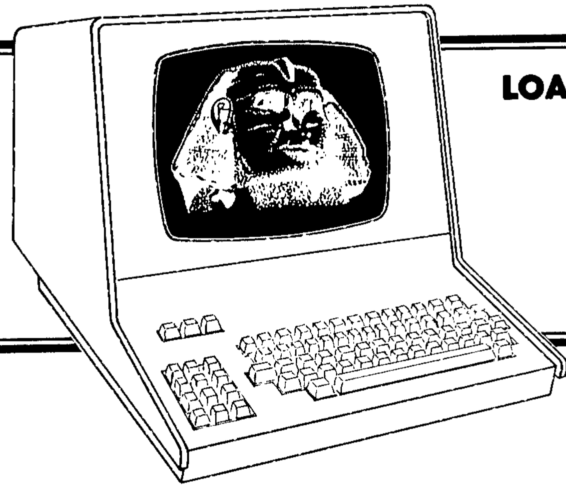

LOAD PLANNING, RAPID MOBILIZATION AND THE COMPUTER

Captain Walter F. Huebner
Chief, Data Automation
New Mexico Air National Guard
150th Tactical Fighter Group
Kirtland AFB, New Mexico 87117

ABSTRACT

One of the thornier problems in modern military mobilization procedures is the amount of planning time required to accurately and efficiently place equipment and personnel on cargo and Civilian Reserve Air Fleet (CRAF) aircraft. Recent studies of Air Force organizations indicate that many load plans at the unit level are produced manually. The quick response that will be required by the Rapid Deployment Force (RDF) restricts the time allowed to generate airlift load plans for a given contingency, hence severely straining the ability to manually generate effective load plans for mobilization. As a solution, the availability of high speed computers offers capabilities which load planners can use to generate quick, accurate, and near optimal loads, thereby improving our overall logistics effort.

The New Mexico Air National Guard (NMANG), is tasked with maintaining a capability for rapid mobilization in time of war. These mobilization requirements demand plans which designate in detail how equipment and personnel will be placed on aircraft for transfer to theater operations. It is the "Load Planner's" job to generate and maintain these plans. The advent of modern computer technology now offers to load planners the tools which ought to be used to increase the capability to effectively employ the current airlift resources. This article describes the load planner's problems, discusses how a computer can be used to solve those problems, and outlines the method which should be considered as a baseline for a computerized solution to those problems.

"Current manual loading techniques require the load planner to maintain these factors and constraints in his head. . . . "

For approximately four years, the NMANG has been developing a computerized load planning system designed to assist load planners in generating detailed airlift plans for equipment and passengers. The basic load planning function determines the exact aircraft station numbers where equipment is to be placed for a given contingency. The planner must consider many factors: the number and type of aircraft being loaded, the equipment to be loaded, and the passengers, missions, and perhaps a hundred or more constraints which affect the loads. The problem is simply stated, but the solution is not. Current manual loading techniques require the load planner to maintain these factors and contraints in his head, in turn demanding constant manual adjustment of a load plan as it is being generated for DOD Forms 2131 (see Figure 1), 2132, and 2133. As a result, the load planner needs several forms, lots of pencils, large erasers, and plenty of time. Finally, when complete the load planner takes the forms to the equipment marshalling area where equipment and personnel are then gathered and loaded on the aircraft according to the plan.

That is, provided everything goes right! The shift of a piece of equipment by one loadmaster to satisfy some new and unplanned constraint may change the placement of items for a load. The type or configuration of the aircraft for which the plans were generated may change at the last minute. A piece of malfunctioning equipment or frustrated cargo may have to be replaced; another piece of equipment may be added or deleted. Each of these changes may require a new loading plan. These problems are load planner's nightmares, because they can take all of his hard work and render it meaningless in seconds. The result in wasted time, ill-configured airlift loads, disgruntled people, and inefficient use of airlift resources needs a new look.

Now, assume that the load planner had at his fingertips a computer that could remember all of the equipment for which he was about to generate a load plan. This computer could accurately remember the dimensions, weight, hazardous cargo code, and all significant characteristics of that piece of equipment. Further, assume that this computer could then take a list of such equipment, generate load plans for a set of aircraft, and satisfy 90% of the constraints such as floor loading, compartment heights, allowable ramp weight, equipment priority problems, hazardous cargo mixture, cargo door considerations, and even venting locations. And further, assume that such plans were printed for the load planner and easily modifiable by him.

It might be surprising to learn that the Air Force currently performs virtually all of its load plans manually. This includes Aerial Ports, Air Logistics Centers, National Guard Units, and anybody else who performs military airlift. Computerized load planning solutions have been discussed with over 90 military units from all the services, and they are unanimously enthusiastic about the development of this computer tool. The reasons for their enthusiasm are many, but basically there are four major advantages with computerized load planning.

The first advantage is speed. As previously discussed, it takes a lot of time to perform the load planning function. This is because of the extensive amount of information which must be handled. It normally takes 50 to 75 manhours to load plan a TAC wartime aviation package and 15 to 25 manhours for an exercise load plan. Experiments with the NMANG computer program indicate that planning times could be reduced to a maximum of two manhours.

"Manual load planning solutions are fraught with people made errors."

A second advantage is accuracy. Manual load planning solutions are fraught with people made errors. It is too easy to transpose numbers, misadd, forget that a pallet which is more than 76 inches high cannot fit on an aircraft ramp, forget to check that the cargo may fit in an aircraft space, but won't fit through the door, and there are a multitude of errors possible both major and minor. A computer cannot make these errors.

The result of error shows in delayed cargo, which may hold up a deployment or exercise until the problem is solved. A unit's mobilization ought not be held up because of arithmetic or other obvious errors! A computer should reduce such errors to a minimum.

A third advantage is the ability to produce higher allowable cabin load (ACL) percentages. With the burden of accounting for all of the necessary load planning constraints removed from the load planner, he can then spend more time concentrating on solving ad hoc problems.

A final advantage is the ability to have a standard method for generating load plans. This method could be used by the novice as well as the experienced load planner. The computer program could also act as a training tool for the load planning function.

The overall ability to produce loads with higher ACL percentages has a massive snowballing effect. Higher percentages mean a more efficient use of airlift resources, resulting in reduced aircraft fatigue, fuel consumption, and manpower requirements. It is important to recognize that the computer program is useful not only for actual mobilization, but for exercises, deployments, and even on a daily basis by units which transport a large amount of equipment. Hence, the cost savings could be dramatic and should far outweigh the software development costs.

The development of a computer program does not just happen - it must be carefully considered. The objectives for the development of the program used by the NMANG are considered necessary to provide a valid solution to the load planning problem. These objectives are *(1) keep it simple, (2) use standard load planning procedures, (3) provide for a versatile system, and (4) allow rapid implementation throughout using agencies.*

First, there are two reasons for keeping it simple. A computer program that requires a large amount of computer memory and/or processing time defeats the purpose in urging rapid load planning solutions. The second reason for simplicity is that making the program small makes it easily portable, convertible, and usable. A collateral benefit is that the program can easily be operated by the beginner as well as by the expert. Few will use a load planning system that is so cumbersome that only an experienced technician can operate the program.

Another objective is to follow known load planning procedures. One such procedure is known as pyramid loading, in which the heaviest piece of equipment is loaded in the wing area, with lighter equipment then pyramiding out to the ends of the aircraft. These loads are generally better balanced and give the Load Planner a good first cut at settling a load.

"The computer program written to solve the load planning problem must be quickly adaptable to every conceivable user."

A third objective is versatility. This means that the program must be usable anywhere, anytime, for anything. When the load planner needs a solution, he must be able to obtain it rapidly, not have to wait for two or three hours. He must be able to handle any kind of aircraft imaginable, not only C130s, C141s, or C5As. He must be able to use the program as easily in the field as he does at his home base. Without versatility, the load planning problem is not really solved because the limitations then imposed allow the load planner to use the computer only when there is a long lead time before the plans are rquired. Changes to the plans on an emergency basis must then be made by manual methods bringing us back to the pre-program era.

The final development objective is rapid implementation. The computer program written to solve the load planning problem must be quickly adaptable to every conceivable user. The exact computer system on which the load planning program will be implemented for universal use has yet to be determined. It could be a large time sharing system, a regionalized time sharing system, and/or individual microcomputers. Realizing that the rapid implementation objective is obtainable if the previous objectives are followed, it is essential to pursue the solution to the load planning problem while discussions concerning its implementation are being held.

The combination of techniques used by the NMANG load planning computer program are unique. They consist of: *(1) interactive terminal operation, (2) aircraft parameterization, (3) simulation of manual loading methods, and (4) model aircraft floor loading concepts.* These techniques are considered vital to solving the load planning problem and will be discussed in some detail.

The most important of the techniques is interactive terminal operation. Pesonnel who are operating the computer program give instructions to the program as it is executed on the computer. This method allows the operator to use the computer as a tool to view the program's answers as they are being generated. The ability of the program operator to take generated answers and change them to satisfy new constraints, while maintaining the old ones, allows the program to operate in the "keep it simple" environment. Interactive operation also allows the operator to obtain solutions quickly, an extremely vital requirement of the program. Another advantage to interactive operation is that the operator does not have to be at the physical location of the host computer. Hence the system becomes much more versatile: a load planner could plan for a deployment at his home base, then take a remote terminal with him to plan the redeployment from the new location, yet still use the same computer. These are only a few of the advantages in using an interactive terminal operation.

A second technique used by the NMANG is aircraft parameterization. The user describes to the computer program the type of aircraft which is to be loaded, and obviously the aircraft description must follow the standard. Also, default values for common aircraft such as C130s, C141s, C5s and CRAF will be built into the program for user selection. But the user will also have the option to use any aircraft as a source for loading simply by following the data input rules. This method will allow the testing of load plan generation for the C-X without having to modify the computer program itself. Other programs have also been written to solve the load planning problem, but none make use of the interactive technique described above, and all seem to be hardwired to allow a limited selection of aircraft types. Data parameterization overcomes the latter problem.

The third technique used is that of simulating manual loading methods. The most efficient use of airlift resources is obtained through maximum aircraft loads. However, the mathematical algorithms for maximum performance of a problem which has as many constraints as does that of aircraft loading are extremely difficult to develop and program. While it is not implied that such algorithms could not be used, the amount of time necessary to determine a purely mathematical optimization of the load planning constraints is initially prohibitive. In addition, questions were raised very early regarding even the validity of an optimal solution. Due to the large number of constraints involved, a solution which is not programmed to consider even one of the many constraints would not allow the user a means of adding or accounting for that constraint. For these reasons, an approach was taken to model the manual methods of loading. The advantage of this technique is that it is easier to program, easier to change, and

the end product is more realistic. The maximum load problem is partially solved by allowing the computer to generate many solutions to the load plan by varying the order in which equipment is loaded. Hence, the solution comes close to "the best load" in light of the constraints considered, but still allows the user to account for unique constraints. The modeling of manual loading methods therefore has operational advantages over a purely mathematical optimization approach.

A final important technique used is the concept of floor loading, which allows the program user an option to choose the accuracy of the spatial floor constraints. The NMANG program models the aircraft floor by dividing it up into equal square areas, the size of which are determined by the user. As every load planner knows, his plans are only as good as the data, e.g., equipment dimensions, supplied to him. However, a pallet which is listed at 88 by 108 inches may in fact be one inch longer due to a piece of equipment sticking out by just that much. If the load plan put each piece of equipment exactly adjoining the next piece of equipment, the result may be an invalid load. Therefore a factor allowing six inch square modeling of the aircraft floor areas means that the program will assume in some instances that a square is completely occupied when it is not, and vice versa in other instances. This "factor" provides flexibility in the load, and hence produces a load that is adjustable by the user when necessary. Investigation into the size of the "factor" and the need for most efficient end load is currently being performed.

The concepts discussed in the above presentation do not mean to imply that the load planning problem is solved. There has been significiant progress made toward the solution, but much work remains to be done. The purpose of this article has been, therefore, to explain what the problems in load planning are, the advantages that modern computer technology has provided for the solutions to those problems, and the techniques used by computer application which seem to provide valid approaches, in a technical sense, to the problems. It is also hoped that the reader will see the advantages of using computers to solve other operational logistics problems. The tools are here now, and we must take advantage of them if we are to improve our capabilities to remain a strong military force in an increasingly threatening world.

Editor's Note:

HQ MAC, with the approval of HQ USAF, is developing a load planning capability for cargo being airlifted by MAC. The new system is part of the consolidated Aerial Port Subsystem (CAPS). CAPS will be prototype tested at the Dover AFB aerial port during the first quarter of CY 82. The load planning capability that MAC is developing will be more sophisticated than the system described in the above article. The MAC capability will include physical characteristics of MAC cargo aircraft plus charter carriers, (Boeing 747, DC 10, Lockheed 1011, etc.). In addition, it will consider weight and balance, age and priority of cargo, load sequencing, hazardous cargo, fuel factors, etc.

While the system described in this article may not satisfy all the MAC system requirements it reflects the author's initiative in addressing a problem area of his unit and finding a good solution.

Bright Star After Action Report

During the period from 11 through 25 November, 1980, the New Mexico Air National Guard participated in exercise Bright Star 81. The purpose of this exercise was to conduct training maneuvers with Egyptian military forces in the Mideast environment. The exercise involved approximately 1200 Army Airborne and 300 Air National Guard and Air Force personnel, and was conducted at Cairo, Egypt. Due to the absence of adequate military facilities at Cairo, Harvest Bear and Harvest Eagle kits were flown in to set up operation under a bare base situation. At the termination of the exercise, personnel and equipment were removed from the site.

From a logistics viewpoint and more particularly from a Load Planner's viewpoint, all of the problems involved in moving personnel from one location to another were present. Everything from last minute changes in personnel and equipment to receiving unplanned-for aircraft plagued the load planning effort. One of the factors affecting the deployment was the rather short five week notification period to plan for such an unusual exercise. Another factor which emphasized the need for computer solutions to load planning problems was that halfway through the deployment, a C141B (stretch) model landed, whereas we had been told to load plan for only C141A's. As a result, the ALCE loadmaster decided to attempt to fill the entire C141B with cargo, which meant we had to tear up all load plans for the remaining five aircraft and start over, at the last minute! The resulting confusion meant that several of the post deployment load plans which arrived in Cairo did not reflect accurate cargo manifests. This situation resulted in our not knowing all of the equipment which had arrived, and made planning for the redeployment even that much more difficult.

A significant event which occurred during this exercise was the transportation of a microcomputer to Cairo on the military aircraft. The purpose of this microcomputer, an Apple II with 48K, video monitor, and floppy disk, was to prove the capability of using computer technology in a forward area of the battle environment. The experiment was highly successful, and even though the computer operated by electricity supplied by gas powered generators and in an extremely harsh climate, there were no hardware problems. During the exercise a computer program was written which graphically displayed the upper half of current load planning forms (DD2131, 2132, 2133), and which was used to verify the validity of load plans manually produced for redeployment stateside. The program was written in BASIC by the author of this article, who has considerable computer experience but had never used a microcomputer, and shows the ease with which these machines may be learned. This computer has the capability of being used at the home unit, in the field, or even on the aircraft itself.

In addition to providing a tool for load planning, there were many uses seen for microcomputers in the field. Such activities as preparing cargo manifests, keeping track of equipment monitors, logging fuel used on a daily basis, and recording personnel locations and telephone numbers are only a few examples of how computers could be used. Any activity which requires storing and retrieving a large amount of information is useful for microcomputer application.

It is recommended that the use of microcomputers to solve operational problems be explored further. The development of a single program does not prove that the entire load planning operational problem can be solved using a microcomputer, but it does demonstrate that the potential exists and should not be ignored. It is hoped that research in this area can continue beyond Bright Star 81.

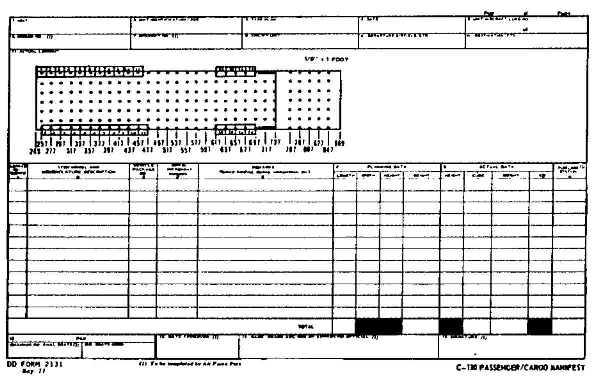

Figure 1. DOD Form 2131

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Base Audiovisual Service Center Contract Conversions: A Follow-up Cost Effectiveness Study

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Utilization of Advanced Academic Degrees in Acquisition Logistics Division of AFLC Under a Percentage Based System

AIR FORCE HUMAN RESOURCES LABORATORY
FY 82-83 LOGISTICS R&D PROGRAM

The Air Force Human Resources Laboratory, with Headquarters at Brooks AFB, Texas, is the principal organization charged with planning and executing the USAF exploratory and advanced development programs in the broad areas of: (1) Manpower and Force Management; (2) Air Combat Tactics and Training; (3) Weapon Systems Logistics, Maintenance and Technical Training. The latter thrust area is functionally managed by the Logistics and Technical Training Division of AFHRL located at Wright-Patterson AFB, Ohio. All of the Laboratory's efforts to improve Air Force logistics are managed within this thrust area. Some efforts are undertaken in response to technology needs identified by the laboratory, but the majority of the work is in response to formally stated requirements from various Commands and staff agencies within the Air Force. In nature, projects vary from basic research aimed at producing new fundamental knowledge to applied projects which are intended to demonstrate the technical feasibility and military effectiveness of a proposed concept or technique. In content, projects vary from those which are directed at the development of more supportable weapon systems to those that are aimed at more effective maintenance in the field. Whatever the nature and content of the R&D, the primary focus of work within this thrust area is on developing a combat logistics capability which is anchored in sortie generation rate.

Below are described the logistics R&D projects being managed by the Logistics and Technical Training Division which will be active during FY82 and FY83. Some will be completed during this period while others will extend beyond. Status and schedule information is given for each project. If you have an interest in any of these efforts, contact the project officer listed. For general information about the total program,. contact Colonel Donald C. Tetmeyer, AFHRL/LR, Wright-Patterson AFB, Ohio, Autovon 785-3713/6797, Commercial (513) 255-3713/6797.

R&D PROGRAMS

DEVELOPMENT OF MAINTENANCE DEMAND METRICS
OBJECTIVE: To identify the hardware, operations, and environment parameters which drive the maintenance demands of a weapon system, and to develop more accurate metrics to be incorporated into the Air Force method (LCOM) for determining manpower and other resource requirements for operational and developing aircraft weapon systems.
APPROACH: The work is being carried out in three phases as follows: Phase I - Develop metrics for avionics and engine subsystems; Phase II - Develop metrics for all additional aircraft subsystems; Phase III - Develop metrics for all subsystems by aircraft type (i.e., tactical, strategic, transport). During each of the three phases, the following major tasks are performed: (1) review relevant research of the preceding 15 years, (2) select equipment representative of current Air Force weapon system hardware, (3) identify hardware, operations and environmental parameters impacting maintenance, (4) review and identify data sources providing information to facilitate the analysis of parameter effects on maintenance, (5) perform analysis to test and define the relationship between the identified parameters and maintenance demand rates, (6) develop models relating the hardware parameters to maintenance demand rates, resulting in metrics which are compatible with Logistics Composite Model (LCOM) input requirements, (7) develop models relating operation and environmental parameters to maintenance demand rates, (8) perform analysis to determine the results of using the developed metrics in LCOM simulation.
STATUS: Phase I - Completed; Phase II - Completed; Phase III - Sep 82
POINT OF CONTACT: Frank A. Maher, AFHRL/LRLA/AV 785-6555

TECHNOLOGY FOR ACQUIRING SUPPORTABLE SYSTEMS
OBJECTIVE: To develop and demonstrate a technology for reducing the life cycle cost and improving the supportability of new systems by assuring the integrated consideration of manpower and related logistics factors in system design and support planning decisions.
APPROACH: The current effort is the final phase of a four phase effort. Phase I - Perform a historical analysis of the life cycle costs of the C-130E aircraft in order to determine the availability of relevant data sources and the major drivers of ownership cost. Phase II - Integrate tools and techniques from five human resources related technical areas into a single, coordinated technology, establish the characteristics of the consolidated data base necessary to support this consolidated technology, and demonstrate the application of this technology and data base in a weapon system development program. Phase III - Develop a computerized personnel availability model, data bank and application methodology to support the evaluation of system support personnel requirements in terms of estimates of their future availability. Phase IV - Complete the evaluation and debugging of the products developed in the previous three phases and prepare the technology package for transition to the user. This is to include the development of users guidance and training materials to allow both management and engineering personnel to gain an understanding of the capabilities and limitations of the technology and to provide them with a "bootstrap" capability to implement the package or any of its components.
STATUS: Phase I - Completed; Phase II - Completed; Phase III - Completed; Phase IV - Sep 82
POINT OF CONTACT: Rosemarie J. Preidis, AFHRL/LRLA/AV 785-3771

SPECIFICATION FOR ULTRASONIC NON-DESTRUCTIVE INSPECTION TRAINER
OBJECTIVE: To develop specifications for a prototype trainer to be used to develop, measure and sustain the ability of Air Force personnel to use ultrasonic non-destructive inspection (NDI) systems.
APPROACH: The specification will be generated by using previously developed

procedures for specifying the required characteristics of maintenance simulators. The first step is to develop systematic descriptions of performance capabilities of the trainer based upon the behaviors to be developed, measured and sustained by the device. The next step is to determine engineering/physical characteristics which the trainer must have in order to provide the required functional characteristics.
STATUS: Program start - Sep 81; Completion - Sep 82
POINT OF CONTACT: Robert H. Sommers, AFHRL/LRT/AV 926-3391

UNIFIED DATA BASE (UDB)
OBJECTIVE: To develop an automated on-line database of logistics information to support the Weapon System (WS) acquisition process.
APPROACH: Phase I - Determine the existing data needs of logisticians, engineers, and managers during the WS design and acquisition process. Also determine the corresponding availability of the identified data during the time frame that it is needed. This is being done via a survey of the Aerospace Industry under the auspices of the Aerospace Industry Association, and via a survey of the appropriate Air Force Logistics Command, and Air Force Systems Command personnel. Phase II - Develop the required software and associated User's Guides, which will address the identified data needs for an on-line automated system. Phase III - Test the system and demonstrate it on a WS in development.
STATUS: Phase I - Oct 81; Phase II - Jan 82; Phase III - Feb 83
POINT OF CONTACT: Robert N. Deem, AFHRL/LRLA/AV 785-3771

ANALYSIS TO IMPROVE THE MAINTENANCE ENVIRONMENT
OBJECTIVE: To develop a comprehensive, integrated, long-range research and technology application program designed to increase the overall effectiveness of Air Force maintenance operations.
APPROACH: Conduct approximately 2700 open ended interviews with maintenance technicians, supervisors, managers and planners representing the areas of active duty aircraft, Air National Guard and Reserve, and missiles. Data will be categorized and consolidated into descriptive systems and used in developing and prioritizing both areas of promising technolgy applications and future research requirements.
STATUS: Planning - Completed; Active duty aircraft data collection - Oct 81; ANG and Reserve data collection - Jan 83; Missile data collection - Jun 83; Applications and research plan development - Sep 83
POINT OF CONTACT: Richard E. Weimer, AFHRL/LRLM/AV 785-2606

IMPACT ANALYSIS OF THE INTEGRATED COMMUNICATIONS, NAVIGATION, IDENTIFICATION AVIONIC (ICNIA) SYSTEM
OBJECTIVE: To identify tools and techniques to incorporate logistics engineering parameters into system design during the conceptual phase. These analysis techniques will be demonstrated by applying them to front end analysis portion of the INCIA conceptual phase.
APPROACH: This effort will include three major tasks applied to two conceptual ICNIA system architectures that were developed by the Air Force Avionics Laboratory. Incorporated into these tasks is a front end analysis to determine the problems associated with logistics engineering during the conceptual development of new avionics and to identify the techniques needed to accomplish the analysis. The three major tasks will develop, apply, and evaluate logistics support concepts of maintainability, reliability, and survivability to the two ICNIA systems' architectures. A User's Handbook and Guidance Document will be prepared addressing the rationale and logic behind the analyses identified and/or developed, and provide sufficient detail and clear guidance for use of these analyses.
STATUS: Program start - Nov 81, Maintainability task - Sep 82, Reliability task - Jul 83, and the Survivability task - Oct 83
POINT OF CONTACT: James C. McManus, AFHRL/LRLA/AV 785-5910

SIMULATION FOR MAINTENANCE TRAINING
OBJECTIVE: To develop model specifications, user handbooks, and life cycle management guides for the effective utilization of simulation in maintenance training. This program will consist of building a baseline knowledge of techniques, procedures, and principles necessary for broad applications of simulation in maintenance training. Demonstration of the training and cost-effectiveness of simulation techniques coupled with analyses of effective simulation management tools will provide the necessary empirical data.
APPROACH: The approach taken emphasizes three major tasks: (1) development of prototype maintenance simulator training systems; (2) comprehensive test and evaluation of simulator system cost and training effectiveness; and (3) preparation of user handbooks and model specifications for application in future weapon system trainer developments. This program will develop several prototype maintenance training simulators which will be used to generate a baseline knowledge of simulator instructional design, display technology, courseware design, concepts for hardware/software modularization, simulator evaluation, and cost/fidelity/transfer-of-training relationships for broad application to technical training. The documentation developed will provide appropriate Air Force personnel with the information necessary to effectively define, acquire, utilize and maintain effective maintenance simulators.
STATUS: Development of prototype maintenance simulators - Sep 82; Simulator effectiveness evaluations - Sep 83; Handbooks and specifications - Sep 84
POINT OF CONTACT: Edgar A. Smith, AFHRL/LRTT/AV 926-3391

LOGISTIC IMPACT RESEARCH/TECHNOLOGY TRANSFER
OBJECTIVE: To provide a capability for quick response R&D support in areas of maintenance such as: Fault isolation improvement; maintenance and logistics readiness forecasting; integrated logistic support test and evaluation; and maintenance performance enhancement. Also, to provide for specific efforts to promote the utilization of previously developed R&D products.
APPROACH: Contractual provisions will be made for rapid response to research needs identified from sources such as HQ USAF, MAJCOMs, other laboratories or internal AFHRL requirements. Specific studies have not been identified at this time. However, the following general approach will be followed for each research requirement: (1) the specific research problem and requirements will be defined, (2) necessary contractual arrangements will be made, (3) the contractor or a subcontractor will accomplish the research, and (4) the results will be disseminated and applied. In addition, efforts will be made to encourage and facilitate the application of the results and products of these studies and other AFHRL projects for use by Air Force and other DOD agencies. This will be accomplished through the use of briefings, seminars, and consultations by Laboratory personnel.
STATUS: Program Start - Sep 81; Completion - Jan 85
POINT OF CONTACT: Wendy B. Campbell, AFHRL/LRLM/AV 785-2606

REDUCING DIAGNOSTIC ERRORS IN FAULT ISOLATION
OBJECTIVE: To develop and demonstrate techniques and methods for reducing errors in fault isolation on complex aircraft systems.
APPROACH: This effort will be carried out in three phases. Phase I - Field data will be used to identify at least ten LRUs experiencing high retest OK and/or cannot duplicate rates. Phase II - Three or four LRUs from the list generated in Phase I will be selected for detailed study. Efficient experimental designs will be employed to empirically identify the sources of error and unreliability in diagnostic decisions. Potential corrective measures will be identified (e.g., job instructions, training, equipment design). Phase III - The potential corrective measures identified in Phase II will be implemented and evaluated in limited field tests. Guidance documents will be prepared, based upon the results obtained, which will address the reduction of diagnostic errors on fielded systems, as well as the design of fault isolation systems for new equipment.
STATUS: Program start - Apr 82; Phase I - Sep 82; Phase II - Sep 84; Phase III - Sep 85
POINT OF CONTACT: Alan E. Herner, AFHRL/LRLA/AV 785-3771

AUTOMATED MAINTENANCE PERFORMANCE AIDS
OBJECTIVE: To develop and evaluate two prototype automated aids for the presentation of technical information for use by maintenance technicians. One aid will be for the presentation of technical orders; the other aid will be for the presentation of specialized technical data for use in assessing aircraft battle damage.
APPROACH: A series of small design studies will be accomplished to establish system requirements for factors such as display resolution, data presentation formats, and the man/machine interface. Based upon the results of these studies, the systems will be designed, developed, and evaluated. In designing the systems, emphasis will be placed on developing systems which are easy to use, provide all of the information that the technician needs, and increase the technician's capability to perform maintenance. The systems will be evaluated by formating and displaying technical data for test bed equipment. The data will then be used to perform maintenance tasks and to assess simulated aircraft battle damage. Finally, specifications will be developed for the hardware, software and technical data.
STATUS: Program start - Early FY82; Completion - FY85
POINT OF CONTACT: Donald L. Thomas, AFHRL/LRLM/AV 785-2606

EXPLORE MAINTENANCE AND LOGISTICS ALTERNATIVES
OBJECTIVE: To develop tested policies, procedures, training techniques and organizational structures that, when applied, will enhance the capabilities and performance of maintenance personnel and organizations.
APPROACH: Under a related effort (Analysis to Improve the Maintenance Environment) a research plan and a set of proposed research studies (prioritized according to need and payoff) will be developed. In this effort, high priority research studies will be accomplished. Specific studies have not been identified at this time. However, the following general approach will be used for all studies: Phase I - Problem definition and research design development; Phase II - Conduct research; Phase III - Report results and transition technology developed; and Phase IV - Follow-up to insure proper application of technology and evaluate impact.
STATUS: Program start - Jan 82; Completion - Sep 86
POINT OF CONTACT: Robert C. Johnson, AFHRL/LRLM/AV 785-2606

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Precepts for Life Cycle Cost Management

Roland D. Kankey
Assistant Professor, Quantitative Management
School of Systems and Logistics
Air Force Institute of Technology
Wright-Patterson Air Force Base, Ohio 45433

Introduction

Life Cycle Cost Management and Design to Cost are phrases that have bothered logisticians for the past decade. Can they be defined? can they be achieved? and above all, what needs to be done to satisfy the demands of these concepts?

Life Cycle Cost Management

The life cycle cost of an item is the total cost of development, acquisition, ownership and disposal directly associated with or due to the item. The item can range in size from a computer chip to a weapon system or even an organizational change. LCCM requires the estimation of LCC for alternative items before decisions are made on the alternatives. We cannot avoid it for lack of alternatives since, given the right viewpoint, all decisions have alternatives, even if one is to do nothing at all.

LCCM thus levies a requirement to estimate these alternative costs with a concurrent search for guidelines and data. We must consider these costs, with their inherent uncertainties, as a factor when trying to select the optimum alternative; the one with the best combination of benefits and cost. Points considered under benefits are performance (speed, payload, MTBF), schedule (Initial Operating Capability, production rate), and cost (acquisition, operating, support). If the alternatives can be adjusted to a common performance or mission accomplishment level and schedule, i.e. we are in an equal benefit position, then the optimal or best alternative can be selected based on lowest life cycle cost. However, if they cannot be adjusted to a common mission accomplishment level, i.e., we are in an unequal cost, unequal benefit position, the guidelines require use of economic analysis techniques.

Regardless of the analysis technique used, LCCM requires that costs considered be "total costs driven by the decision." Sunk costs and cost elements not affected by the decision need not be considered. This opens the door for the use of variable costs in LCC analysis. Total costs generally do not need to be estimated, since many elements of cost are expected to be equal for all alternatives and therefore can be excluded.

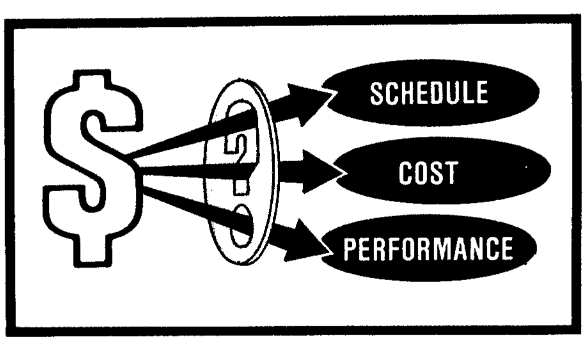

Figure 1: LCC Management Requires the Best Balance of Performance, Cost, and Schedule

What decisions require consideration of total costs? Every decision which results in use of resources, where resources can be money, labor hours, or equipment, should be made based on total costs. Now, who makes these kinds of decisions? Almost all of us make them on a personal and business level. The concept is often applied when we make decisions such as which house to buy, which car to buy, or which tools to buy.

Design to Cost

A particular subset of LCCM pertains early in the acquisition cycle of an item. When items are being designed to satisfy an identified need the designs themselves will "drive" costs. Thus design becomes an item of concern and "design to cost" is appropriate. The concept is not new. Analysis of the market may prompt a commercial company to design a $29.95 vacuum cleaner or a $12.95 smoke detector. The company's designers can be given a maximum cost or target to shoot for. Thus costs drive their design. Under the DOD equivalent Design to Cost Concept, a cost target or goal is established early in the development and the item is then designed to meet that cost target. The target can be in terms of production cost or life cycle cost. More on this later.

Now how can this be accomplished? What needs to be done? The following seven precepts provide some structure to the process.

LCCM Precepts

1. Overcome inertia
2. Develop a questioning approach
3. Do your quantitative homework
4. Iterate the design
5. Trade
6. Assure contractor commitment
7. Keep user involved

To manage LCC you first need to *overcome inertia*. "We have always done it this way." "Don't rock the boat!" "That's their problem." These phrases indicate inertia. People are very comfortable doing things the way that was successful before. People and organizations resist change. How can you overcome inertia? how can you change people's attitudes about management of resources? how can you convince them that total (i.e. life cycle) costs need to be considered as the equal of performance and schedule? To start with, the leaders must believe it and publicize their belief that LCC IS A VALID DECISION ITEM and the LCC management can work to everyone's advantage. In DOD this has been done at the highest levels. We have directives and regulations which document their belief and support.

As a follow-up to his belief you must then assure that all your people are educated on LCCM. One person indicated that LCC programs were like a Viking ship with only the leader looking ahead—all the others were looking backward. This may work on a ship, but it is not the way to run an LCC

program or to make an LCC decision. All people associated with this decision should know how the task is different from before and how their role must be changed. Once your people know what LCCM is and what it hopes to accomplish, the next step is to *develop a questioning* approach. If cost, performance, and schedule are of equal importance, none can be considered fixed. In the past we in DOD tended to accept the performance and schedule requirements as given. They were needed for the defense of the nation and naturally cost was of little importance when compared to the nation's defense needs. But, when our leaders looked at the costs of our long-range plans they quickly noted that the quantity of resources needed was not going to be available. We were rapidly committing all our future resources through our current decisions. Was this the best way to manage the nation's defense? In 1975, Secretary of the AF John L. McLucas stated "management is the biggest challenge Air Force people face today . . . the foundation of our success as a deterrent force is not going to be determined by 'flying and fighting' but by how well we manage our limited resources." This challenge applied throughout DOD. A questioning approach needed to be developed from the top down. The Office of Management and Budget published guidance which prompted the set up of Milestone ϕ in DOD's acquisition process. They wanted the "need" for a new capability questioned before resources were committed. If the need itself can be questioned, all aspects of performance and schedule must be questioned. Once costs have been calculated, those requirements which have significant cost impacts must once again be questioned. Is that increase in performance or earlier schedule worth the cost? If costs are fed back to the originators, it is very possible that they will change some of the requirements. With resources tight and many competing places to spend them, an item or system that carries much costly gold-plating could easily fall victim in a review, and the user is well aware of this. Early in the development of the ARC-164 radio, one of our best LCC examples, every performance requirement proposed for that item was questioned. They attempted to identify the minimum necessary requirements. You need to do the same.

To help the user or designer identify the high cost items requires that you do *your quantitative homework.* Consideration of LCC in decisions requires estimation of total variable costs. In most cases data is available or can be developed which will allow adequate estimation of cost. Decisions based upon gut feelings may be right or wrong, but they are not supportable without quantitative backup. To paraphrase a conversation with an analyst from a current large program, "a decision was made to use contract maintenance based upon a gut feel that it had to be cheaper." The analyst later spent several weeks developing the cost estimates which did indeed support the decision. Others have not been so lucky. With the high level DOD interest in using LCC as a decision criteria, failure to do your quantitative homework can severely weaken your position. Methods and techniques used to develop these costs vary with the type of item, timeframe, technology, and resources available. Development of the costs is not the end of the process. Costs are now an active parameter. This means you are expected to use them in design iterations or in trades with performance and schedule.

Iterate the design is next. When DTC is appropriate, the costs must be fed back to the designer and he must be given time to rework the design. By redesigning high cost driver portions the total cost can be decreased. If costs are not important, the designer usually stops with the first workable unit that satisfies performance requirements. Under DTC he must continue to iterate the design until the estimated cost meets the cost target. Without time to iterate the design a DTC program loses much of its effect. Mr. Jacques Gansler, at a National Estimating Society meeting in 1981, said that commercial companies often overrun their R&D estimates but almost never overrun manufacturing cost targets. You need a similar attitude.

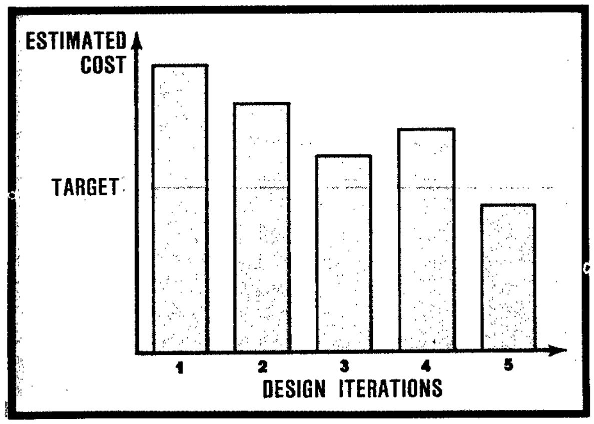

Figure 2: Design Iteration Can Result in Cost Reduction

Under LCCM, performance, schedule and cost are tradable items. All the precepts up to this point provide the ability to *trade.* Now in many cases the item will have a minimum performance level and it will have a schedule as to when needed. LCCM does not attempt to reduce these levels, merely to identify them so you can trade-off additional performance and better schedule with costs. Those options (sometimes designs) which meet performance, schedule and cost requirements must all be considered.

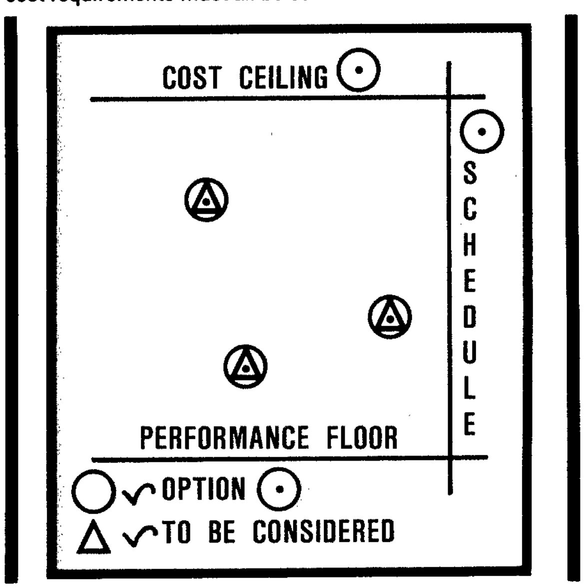

Figure 3.

The most interesting trades are those between different portions of cost; i.e., trades that increase acquisition cost but decrease ownership cost. Almost any LCC decision requires this kind of trade. To illustrate this, let me summarize three examples: (1) aircraft tires, (2) ARC-164 radio, and (3) AMST proximity switch vs microswitch.

Tires

For years aircraft tires (like most other consumables) were bought by selecting, from among the sellers who met the specification, the one who offered the lowest price. We ran into the problem described by John Ruskin when he said, "There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people

who consider price alone are this man's lawful prey." Rather than base the decision upon price alone, samples were purchased from several contractors. Tests were run to find the average landings per tire for each. Cost per landing was then developed and used as the criteria for selection. This approach gave different results than the old "buy the cheapest" approach, with considerable LCC savings. We paid more for the tires at the beginning but they lasted longer. That is both effective and efficient.

Radio

The AF needed a new aircraft radio. Existing radios were experiencing high failure rates and were technologically out of date. A program was begun to design and buy a new radio which was keyed from the beginning as a LCC program. When the request for proposal (RFP) was sent out, LCC was noted as the most important selection criteria. Included in the RFP were the LCC model to be used and the cost sharing procedure to be used if the actual operating costs were over or under those proposed. The company which won the award was able to show that they offered the best total cost to the AF. This program was very successful.

Switch C

While work was progressing on the AMST aircraft numerous LCC decisions were made. In one case it was noted that either a microswitch or proximity switch could be used to indicate when wheels were up and locked. The microswitch (used in the past) was cheaper to buy and its use would help keep acquisition costs down. The proximity switch was more expensive but would require less labor to replace if it failed, thus reducing ownership costs. It was shown that the ownership cost savings of the proximity switch was sufficient to offset the acquisition cost advantages of the microswitch.

These three are not the only examples available, but they do indicate that a questioning attitude and quantitative backup can result in total cost savings through trades.

The next precept, to assure *contractor commitment*, reminds us that the contractor himself does a great deal of the work. If he is not committed to providing a product with good LCC characteristics you probably will not get them. The first step in this process is to convince him that you are serious about LCC. You have overcome the inertia and educated your people as to what is expected from LCCM. They are giving a consistent view to the contractor. The next step then in the process is to have LCC high in the list of selection criteria. The third is to have some form of ownership/cost incentive on the contract. With the aircraft tires the contractor was obligated to provide additional tires at no charge if the landing index fell significantly below the sample tested. On the ARC-164 radio the cost sharing scenario was given. Here the contractor knew that if his radio tested out better than bid, he received extra money. If it tested out worse, he had to pay a penalty.

Other incentive methods have been tried. These include the support cost guarantee, reliability improvement warranty and contractor maintenance.

Once all the work is done and the item is in place, the cost savings depend upon user commitment. Thus, precept seven is to *assure user commitment*. If analysis indicates two maintainers can now do the same job which formerly required ten, the user has to follow through and reduce manning in that section. If different maintenance practices are required, such as depot vs base repair, the user must make it work. It is thus vital that user inputs be considered before LCC decisions are made. If the user has played a role in developing or selecting the item, that person will be more committed to achieving the savings.

Conclusion

Experience over the past decade shows that LCC management will work and that we have the ability to make decisions based upon total cost. Adherence to these seven general precepts will help assure successful LCC management. To ignore any one of them will decrease your chance of success.

LCCM is quantitative (see precepts 3, 4, and 5). LCCM is also political in the sense of trying to gain a unified approach (see precepts 1, 2, 6 and 7). Those who ignore the political aspects are no more likely to succeed than those who ignore the quantitative ones. Both are required.

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Coming in the Spring Issue

- ▶ **Getting along with DLA**
- ▶ **Strategic Minerals**
- ▶ **Centralized Defense Transportation**
- ▶ **Most Significant Article of 1981 Announcement**

Item of Interest

A TECHNOLOGY TRANSFER

Personal or small business microcomputers have become a necessity to many people. There are numerous ones on the market such as the IBM Personal, the Apple II system, and the Radio Shack TRS 80.

The Analysis Directorate at the Air Force Logistics Management Center is in the process of preparing a short, concise user's brochure for the microcomputer they have. Written for the non-ADP expert, the pamphlet will offer a quick reference guide in four areas. The first area gives instructions on "how to bring up the system," key-in a program, edit the program, save it on a diskette, as well as load and execute it. The remaining three areas concern using the FORTRAN and PASCAL programming languages, the graphics tablet and work processing capabilities. The brochure will be available for distribution.

The Center has a long term interest in the applications of any microcomputer and computer graphics equipment in base-level logistics. Information from users on applications and software would be appreciated. A state-of-the-art survey report is planned for distribution during late FY 1982.

Address any questions or correspondence to Mr. Hahn or 1Lt Daniels at AFLMC/LGY, Gunter AFS, AL 36114, AV 921-4524.

Current Research - continued from page 27

INTEGRATED TRAINING SYSTEM FOR AIR FORCE OJT

OBJECTIVE: To develop an Integrated Training System (ITS) which will provide more effective evaluation and management of Air Force On-The-Job Training (OJT). The ITS will provide quality control of OJT by tracking training requirements and determining that they have been met. Also, the ITS will aid in identifying task level training requirements and providing the data bases necessary for scheduling of training resources/events and monitoring/recording trainee progress.

APPROACH: The initial effort will be an overall system definition and specification. Later phases will involve subsystem development and integration. A building block approach will be used to allow both the orderly development of needed techniques and subsystems as well as the opportunity for incremental applications and payoffs as the work progresses. A final step will encompass test, evaluation and technology transition in order to demonstrate feasibility of the prototype system.

STATUS: System definition and specification - Sep 82; Subsystem development and integration - Sep 86; Test, evaluation and technology transition - Sep 87

POINT OF CONTACT: James R. Burkett, AFHRL/LRTT/AV 926-4388

COMBAT MAINTENANCE CAPABILITY

OBJECTIVE: Develop and demonstrate methods by which the Air Force can measure, quantify, and improve its combat maintenance capability. The demonstrated methods will be used by Air Force decision makers in determining policies, planning resources for combat, preparing units for combat, conducting operational exercises, enhancing combat logistics and maintenance effectiveness, and influencing the design of more supportable future weapon systems. Additionally, this effort is expected to produce substantive recommendations for near-term improvements in the "preparation posture" of Air Force combat maintenance.

APPROACH: An in-depth comparison will be made of peacetime and combat maintenance. Base level maintenance and associated logistics capabilities necessary for successful combat sortie generation will be determined. Issues for successful combat sortie generation will be determined. Issues such as Aircraft Battle Damage Repair demands, Chemical/Biological Attack demands, functional survivability capabilities, resource requirements, work organizations, work management approaches, and others derived from the peacetime/combat comparisons will be addressed. Methods and data bases for forecasting resources for combat maintenance will be developed and tested in field conditions. Also, methods for assessment of unit combat capabilities and preparations will be developed. The effort will consist of five phases as follows: (1) Develop peacetime and combat scenarios and determine combat maintenance requirements; (2) analyze data to identify logistics parameters and identify differences between peacetime and combat maintenance requirements; (4) apply procedures, measures, models, and (5) test and evaluate, and report findings.

STATUS: Program start - mid FY82; Phase I - Oct 83; Phase II - Jun 84; Phase III - Jun 85; Phase IV - Mar 86; Phase V - Jun 87

POINT OF CONTACT: Gene L. Stevens, AFHRL/LRLM/AV 785-5910

Logistics Policy Insight - continued from page 9

collection was initiated on 1 Jul 81 that will provide this information on lost or irreparably damaged items. A feedback loop combining damaged items and those lost or irreparably damaged will significantly enhance carrier selection procedures and allow transportation offices to concentrate quality control resources where the need is greatest.

Improving the Acquisition Process

In March 1981, the Deputy Secretary of Defense (DepSecDef) directed an assessment of the Acquisition process. Its purpose was to determine ways to reduce acquisition cost, shorten acquisition time, improve weapon support and readiness, and improve the Defense System Acquisition Review Committee (DSARC) process. Thirty-one specific actions were directed by the DepSecDef which *in toto* represent major changes in the acquisition process. During the next year, the Air Force will be called upon to revise its 800-series regulations and modify its approach to the treatment of logistics and readiness during the acquisition process. The thrust of the actions directed by the DepSecDef is to commit the new administration to improved readiness as a primary objective of the acquisition process. This means that participants in acquisition programs should use readiness as a prime criterion in measuring the potential worth of alternatives during the design of new systems.

Warranties for GSA Items

The DOD has been criticized by various audits for not having a viable warranty program. One aspect of this criticism is the necessity to procure items with warranties when they are on General Services Administration (GSA) Federal supply service schedules.

HQ USAF requested GSA to obtain schedule quotations with and without warranties. GSA replied that it would consider case-by-case requests. Air Force nonconcurred and in January 1981 submitted to GSA a proposed list of items recommended for two-tiered pricing. Action is pending.

Defense Retail Interservice Support Goals Set

The Deputy Secretary of Defense has directed that the Military Services and Defense Agencies increase efforts to achieve savings in the Defense Retail Interservice Support (DRIS) Program and its related Joint Interservice Resource Study Groups (JIRSG). Specifically, the JIRSG studies now underway should be completed by the end of FY83 and a DRIS savings target of $10 million for each of the fiscal years 1983–87 should be met or exceeded. As an incentive to increase interservice support actions which produce savings, local activities are encouraged to reuse savings to support local valid unfunded requirements. The logistics plans office is the OPR for the DRIS Program.

Outstanding Maintenance Awards

AFR 900-46, provides for the selection of the Daedalian Maintenance Award and outstanding maintenance units. The activities in the following categories are the winners for calendar year 1980:

Daedalian Maintenance Award: PACAF 18TFW, Kadena AB, Okinawa
Daedalian Maintenance Award (Runner-Up): SAC 5BMW, Minot AFB, North Dakota
Daedalian Maintenance Award (Runner-Up): USAFE 81TFW, RAF Bentwaters, United Kingdom
Aircraft Maintenance Unit: ATC 47FMS, Laughlin AFB, Texas
Consolidated Aircraft Maintenance Unit: MAC 1605 CAMS, Lajes Field, Azores
Munitions Maintenance Activity: SAC 319MMS, Grand Forks AFB, North Dakota
Ground Launch Missile Maintenance Squadron: SAC 381MIMS, McConnell AFB, Kansas
Communications-Electronics Maintenance: ESC 6920 ESG, Misawa AB, Japan
Depot Maintenance: AFLC AGMC, Newark AFS, Ohio

Information for Contributors

General. The *Air Force Journal of Logistics* is dedicated to the open examination of all aspects of issues, problems, and ideas of concern to the Air Force logistics community. Constructive criticism of logistics as it exists today is encouraged if it is issue oriented, rationally expressed and indicates the positive action necessary for future improvement. Contributions are welcome from any source inside and outside the Air Force.

Scope. The *AFJL* will consider for publication articles and research results that add to the understanding or improvement of any aspect of Air Force logistics from maintenance, supply, transportation, and logistics plans, to engineering and services, munitions, and contracting and acquisition; from base-level and operational units to depot-level and military and civilian industrial and production logistics; from logistics civilian, enlisted and officer personnel and manpower requirements to training and education; from internal organizational structure, policies and procedures to external relations with other services, government agencies, civilian industry and allies; from daily mission support challenges to the logistics aspects of national security objectives and Air Force strategy, doctrine and tactics.

Special Interest. Articles are especially invited that:

□ give the results of the application of sound analytical and research techniques to existing Air Force logistics operations;

□ offer possible alternatives to current operations based on a logical assessment of today's posture and tomorrow's requirements;

□ demonstrate the interrelation of various parts of Air Force logistics systems internally and with non-USAF systems;

□ consider basic Air Force logistics functions and issues from an unusual perspective;

□ focus on logistics and Air Force mission accomplishment;

□ or, provide insight into the reasons for and impact of recent or future changes in Air Force logistics.

Original Material and Revisions. Submitted articles are received with the understanding that:

1. They have not been published nor are being considered for publication elsewhere. Articles based on research planned for publication *only* as an in-house report or in symposium proceedings are acceptable.

2. Those articles with multiple authors have been approved by all. The *AFJL* will work with the lead author in preparing the manuscript for publication with the understanding that any approved changes are acceptable to all.

3. To the greatest extent possible, necessary revisions in the manuscript will be coordinated with the author.

Length. In general, manuscripts should be between 2000-3500 words. Shorter and longer papers may be published on an exceptional basis. Formal research papers should briefly recognize the most significant research accomplished in the area of investigation and the relation of that research to the work addressed in the paper. A 50-75 word abstract should accompany each manuscript.

Format. Manuscripts should be typed with one inch margins, double-spaced on one side of standard size bond paper. References should be numbered and double-spaced on a separate page(s) at the end of the manuscript. The double number system for identifying references within the article should be used, i.e., (7:15), with the first number identifying the number of the source in the reference list and the second number indicating the specific page number in that source. When possible, potential textual footnote material should be incorporated in the main body of the article. Do not include a separate bibliography.

Figures and Tables. Supporting figures, if any, should be numbered consecutively and prepared on separate pages, one to a page. The text should clearly indicate where each figure is to appear. Tables should be numbered consecutively and be prepared within the appropriate text of the manuscript.

Awards. Published articles are eligible to compete for the Most Significant Article Award in each issue. The quarterly award winners will compete for the annual award from the *AFJL*. Selection is made by the members of the *AFJL*'s Editorial Advisory Board. Articles published by the Editorial staff, Contributing Editors, and Editorial Advisory Board are ineligible for the awards.

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Telephone: AUTOVON 921-4087
Commercial: (205) 279-4087

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"Assessing in advance which opposing attributes are most apt to affect the military balance in what ways hence poses perplexing problems. Few U.S. seers before WWII foresaw the Japanese fighting so fiercely or the French folding so fast. Qualitative comparisons between us and Soviet men-at-arms might also contain some surprises if put to the ultimate test.

John M. Collins in *US - Soviet Military Balance*.

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